SOME STOCHASTIC MODELS FOR DEMOGRAPHIC VARIABLES AND THEIR APPLICATIONS

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CERTIFICATE

This is to certify that the entire work contained in this thesis entitled " **SOME STOCHASTIC MODELS FOR DEMOGRAPHIC VARIABLES AND THEIR APPLICTIONS"** by **Mr. Alok kumar** has been carried out under my supervision.

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PREFACE

The population of the world is increasing annually by roughly 100 million persons. Nearly all of this population growth would be in Africa, Asia and Latin America. One half of this would be in Africa and South Asia alone. The population explosion has been a meaningful term and is acknowledged to be one of the most important events of 20th century. The population growth is most rapid in the least developed parts of the world. The situation is also not different for India. Today India's population has crossed one billion mark and is increasing at the rate of 1.85 percent annually.

Thus in most of the developing and developed countries, planners, social scientists and related researchers are engaged in searching the solution of complex problems like hunger, poverty, illiteracy and other socio-economic questions facing the human beings caused due to high rate of population growth. Thus today we are faced with a challenge and population problem is going to be a big concern for the 21st century.

In recent years the challenge of population growth has drawn the attention of demographers and other social scientists to investigate scientific techniques and methods to analyze the data related to socio-economic, demographic and other aspects of human society. The latest innovation has been the use of models for these phenomena. Models can be constructed either by defining the process in mathematical forms or by using certain empirical observations where they are called as numerical models. Unfortunately, the use of models for studying the growth of human population has been scanty due to lack of adequate quantification of information and feasibility of controlled experiment. Although, a number of deterministic as well as stochastic models have been developed and used in science and technology since long back, its application to the problems of demography, an observational science, is of recent origin. However, a number of population and other social scientists are now being engaged in developing models in

demography and other social sciences to provide concise representations of extensive data sets. A model may have a structure designed to represent the social processes believed to underline the observed data or may be purely empirical. Both approaches have their uses. An advantage of a structural model is that it may well provide further understanding of the underlying social phenomena. Formulation of stochastic models and their applications have been receiving a great importance in recent years for their usefulness and applicability in both natural and social sciences. Consequently, some models have been developed to describe the mechanism of factors such as birth, death and migration during the past decades which may be utilized to study the size, growth, composition and distribution of human population in future, and to formulate some suitable population policies.

The objective of this study is to investigate some deterministic as well as stochastic models for various demographic factors to describe the observed phenomenon. There are seven chapters in this thesis. Chapter I is introductory which has highlighted the importance and objectives of this study including a critical review of literature in the area under study.

In chapter II an attempt has been made to analyze the propensity of migration from/to different Indian states and also the variation in inter state migration probabilities over the past two decades through a probabilistic model. The specific objectives of this study are (i) to study the variation in migration pattern in India over a period of last two decades, (ii) to analyze the reasons of migration and changes observed in some predominant regions among different migration streams, and (iii) to estimate inter state migration flows among major states of India during the period 1971-81 and 1981-91. It was found that during 1981-91, the states Maharashtra and Madhya Pradesh were continued to occupy the 1st and 2nd place among the in -migrating states, while the states Uttar Pradesh and Bihar occupied 1st and 2nd place among out-migrating states during both the periods. An

interesting observation came from Orissa where the state was gaining population in 1971-81 was now in loosing group of states during 1981-91.

The aim of the chapter III is to estimate the fertility level in terms of the mean number of children ever born based on the birth histories of ever- married women. Multiple classification analysis (MCA) is utilized to examine the effect of several demographic, socio-economic and cultural factors on the level of fertility. This study has revealed that to get a significant reduction in fertility, the status of women in terms of their education and occupation should be improved as well as old traditional social and cultural taboos and customs be modernised.

In chapter IV some known differentials of the mean duration of breastfeeding (BF) with some explanatory variables have been confirmed as well as some new differentials have been investigated. Both univariate and multivariate statistical techniques are used. Both 'retrospective' and 'current status' reporting of breastfeeding have been utilised for studying the levels and differentials in the duration of BF. The retrospective reporting refer to asking the mother about the duration of BF subsequent to the birth of her last but one child, whereas the current status reporting entail noting mother's BF following the birth of her last child at the survey date. Overall, the findings of this study demonstrate that mothers living in upper strata of the society breast fed for a shorter duration than their counterpart. This study provide an opportunity to examine the duration of the BF in respect of the last but one child (*i.e.* 'retrospective ' data) and the last child (*i.e.* ' current status ' data) which had % censoring. There is debate in the literature as to which of these two types of data give better estimate of the mean duration of BF. As noted, the mean duration BF was found longer in the case of the ' current status ' data (*i.e.* BF following the birth of the last but one child). The ' retrospective' data missed information on some mothers who provided information about their last child in the 'current status' data. Additionally, if there is a change in the duration of the BF with time, the 'current status' data would catch that

change, whereas the 'retrospective' data would miss it. The reporting bias may occur in both types of data sets, but probably these may be higher in the ' retrospective' data due to the longer recall period. Thus, on balance it appears that the ' current status' data provide a better source than the ' retrospective' data for the analysis of the duration of BF.

Chapter V has examined the effects of a number of demographic, socio-economic and cultural variables, as proximate determinants of fertility, on the length of birth intervals analyzed through both the univariate and multivariate proportional hazard models. The first birth interval and last closed birth interval are discussed. In fact these two birth intervals influence the fertility behavior in the early as well as in the late stage of the reproductive span of a couple. The first birth interval has been studied in respect to the last child, and the last closed birth interval is studied in respect to the last but one child.

A pattern of heaping was observed at the multiples of 6 and 12 months in the data of the duration of birth intervals under studied. This is attributable to recall lapses due to high rate of illiteracy among respondents in eastern Uttar Pradesh and the prevalence of various taboos and customs. The mean length of the duration of birth intervals reported was found longer and consistent with other studies in Indian subcontinent than the developed nations. Adolescent sterility, fetal loss, taboos and customs regarding temporary separation of wife and husband just after the marriage, are some of the important reasons for the longer first birth interval. The socio-economic variables at the household level have little and insignificant impact on the length of birth intervals.

Chapter VI has been devoted to study the impact of emigration/ out-migration on various demographic measures. This chapter is divided into two sections. In the first section, the impact of emigration is looked on the birth trajectory and hence on the population size while second section deals with the derivation of some demographic measures viz. the proportion of the

cohort that emigrates and die at the destination, expectation of life, net reproduction rates, average age, etc. in the presence of migration. The proposed expressions are also illustrated with some reasonable values of the demographic parameters.

In chapter VII a number of population projection models have been derived under the stability conditions. The models derived under the gradual change in fertility schedule have been compared with the models proposed under drastic change in fertility schedule. Impact of an increase in age at marriage has also been studied.

The Findings of chapter II has been published in **Turkish Journal of Population Studies** (vol.21, 1999). Chapter III has been accepted in the Journal" **Janshankhya**" for publication. The results of chapter IV have been published in Journal of **Population and Social Studies** (vol.8, 1999). The findings of chapter V have been published in **GENUS** (vol. LVI, n.1-2) and are also presented in the 21st Annual conference of **Indian Association for the Study of Population**(IASP) held at New Delhi, February 14-16,2000. The chapter VI has been published in a book entitled " **Dynamics of Population Change: Emerging issues of 21st Century**"(Shipra publication, New Delhi, edited by R.C.Yadava, K.N.S.Yadava and K.K.Singh, 2000). The findings of chapter VII have been submitted and revised for publication in the **Aligarh Journal of Statistics**.

The author believes that the thesis provides some interesting and valuable results, which may stimulate future research in the field of migration, demographic duration variables and stable population theory. The models and methodologies developed in the thesis will be useful for researchers, planners and other social scientists working in the related fields.

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CHAPTER-I

INTRODUCTION

Population size of the world has increased from 2.5 billion in 1950 to 6.1 billion at the end of the twentieth century (Bongaarts and Bulato, 1999). Such a rapid growth of population throughout the world has increased concern of all because of its intricate relationship with socio-economic development of a society/country. The demographic changes indicate not only the change in population size but also in its composition, distribution and the related development process. Fertility, mortality and migration are considered three basic components of such changes of a nation. The population of the world is increasing annually by roughly 100 million persons. Nearly all of this population growth will be in Africa, Asia and Latin America. One half of this population growth will be in Africa and South Asia alone. The population explosion has been a meaningful term and is acknowledged to be one of the most important events of 20^{th} century.

The population growth is most rapid in the least developed parts of the world. The situation is also not different for India. Today India's population has crossed one billion mark and is increasing at the rate of 1.85 per cent annually (Census of India, 2001). In most of the developing and developed countries, planners, social scientists and researchers are engaged in searching the solution of complex problems like hunger, poverty, illiteracy and other socio-economic questions facing the human beings caused due to high rate of population growth. Thus today we are faced with a challenge and population problem, which is going to be a big concern for the 21^{st} century.

In recent years the challenge of population growth has drawn the attention of demographers and other social scientists to investigate scientific techniques

and methods to analyze the data related to socio-economic, demographic and other aspects of human society. The latest innovation has been the use of models for these phenomena. Models can be constructed either by defining the process in mathematical forms or by using certain empirical observations where they are called as numerical models. Unfortunately, the use of models for studying the growth of human population has been scanty due to lack of quantification of information and feasibility of controlled experiment (Hossain, 2000;Islam, 1991;Sinha, 1998;Yadava, 1993). Although a number of deterministic as well as stochastic models have been developed and used in science and technology since long back, its application to the problems of demography, an observational science, is of recent origin. However, a number of populations and other social scientists are now being engaged in developing models in demography and other social sciences to provide concise representation of extensive data sets. Among others a first and foremost criterion in model building is that it should representative of the phenomenon to a large extent. Keyfitz (1977) has rightly stated, " No model no understanding". A model may have a structure designed to represent the social processes believed to underline the observed data or may be purely empirical. Both approaches have their uses. An advantage of a structural model is that it may well provide further understanding of the underlying social phenomena. Formulation of stochastic models and their application have been receiving a great importance in recent times for their usefulness and applicability in both natural and social sciences. Consequently, some models have been developed to describe the mechanism of factors such as birth, death and migration during the past decades which may be utilised to study the size, growth, composition and distribution of human population in future, and to formulate some suitable population policies.

Migration, especially in the developing countries, plays an important role in changing the socio-economic and cultural environment of the people living in different areas particularly in rural areas and hence, it is expected that

whenever migration occurs, it may have an important bearing on them (Premi, 1984; Singh, 1998 and Skeldon, 1986). A wide-ranging importance of rural to urban migration can be captured under three broad heads: resources flow, information flow and flow of trained manpower. In fact, in most of developing countries including India, majority of the migrants has been found to be pushed rather than pulled. As a result, they migrate, to different places of the destination singly, at least in the beginning, by leaving their wives and kids in the rural areas. This phenomenon of migration in turn acts as a strong catalyst for a constant interaction with their origin places either in terms of visiting at a short interval or by sending remittances for survival of their family staying behind. The scope of migration studies has increase its domain in the context of health transition and emerging health issues for the urban as well as rural areas during the past one decade with increasing incidence of STD, HIV/ AIDS. It has gained wider importance in view of nature and pattern of increasing HIV infection among innocent housewives in rural areas particularly whose husbands have been migrated to different urban centers.

To study variation in the level of fertility of a particular society, it is necessary to look into the mechanism through which it operates. Davis and Blake (1956) have identified a list of eleven key variables which affect natural fertility (natural fertility refers to the fertility which exists in the absence of deliberate birth control) of a society and these variables were divided into three broad categories, namely, i) intercourse, ii) conception, iii) gestation variables. Later Bongaarts and Potter (1983) observed that 96 per cent variation in total fertility rate could be explained by marriage, contraception, abortion and lactational infecundability and hence they identified these four variables as "proximate determinants of fertility"(Islam, 2001). In developing countries, like India, unwanted population growth resulting from sustained high fertility and declining mortality has been contributing a major problem. Fertility rates have declined but these are still high. A total fertility rate of 3.39 has been recorded for India as a whole and there are disparities in its

level among the states. The lowest and the highest TFR occur in Goa (1.9), Kerala (2.0) and U.P (4.8) respectively. Along with the high level of fertility, differentials in fertility have been noted for mothers who have varied demographic, socio-economic and cultural background (NFHS, 1992-93, 1998-99). Thus, a precise measurement of fertility determinants and differentials and their impacts are important in any demographic analysis.

It is well known that human reproduction process functions within a biological framework, but a number of socio-economic, demographic, psychological and cultural factors also act upon it. Breastfeeding is one that affects fertility by prolonging the duration of post partum amenorrhoea and hence, length of related birth interval. The length of ovulation depends on the duration of breastfeeding, especially the intensity and frequency of suckling (Broun *et al.*, 1985), and also on both the return of menstruation and resumption of normal sexual relations (Hall and Simpson, 1985; Santow, 1987).

The benefits of breastfeeding on the health of a child are well accepted. Moreover, breast milk develops immunities in infants against various diseases. Breastfeeding practices vary widely across and within countries. The duration of breastfeeding is generally short in modern western society but it is prolonged and often continues until the occurrence of next pregnancy in traditional societies like, Asia, Africa and Latin America (Islam, 1991). Substantial variation in the length of birth interval according to duration of breastfeeding and duration of post partum amenorrhoea has been noticed in several studies (Page *et al.*, 1982; Singh, 1993; Srinivasan *et al.*, 1989; Trussel *et al.*, 1992; Mannan and Islam, 1995; Nath *et al.*, 1982). Suckling stimulus of breastfeeding has been found to be one of the main reasons for the reduction in fertility and the frequency, intensity and timing of suckling determine the extent of this effect (Guz and Hobcraft, 1991).

Habicht *et al.* (1985) have mentioned that breastfeeding beyond the resumption of menstruation can not affect the duration of PPA and an estimated effect of breastfeeding on fertility may be biased. On the other hand McNeily *et al.* (1985) have pleaded that continued breastfeeding may further delay resumption of ovulation and interfere with the frequency of menstrual cycles. Guz and Hobcraft (1991) have reported, based on a Ghanaian study that the conception rate over the first 18 months of sexually active menstruating exposure for those still breastfeeding was about 10 per cent, and for those who have weaned was about 18 per cent.

Some of the factors associated with differentials in breastfeeding have been region, place of residence-rural/urban, education, social status, mother's age, parity, use of contraception, employment status etc. Based on WFS data, a higher duration of the breastfeeding has been found in African and Asian countries than in Latin American and the Caribbean (McCann *et al.*, 1984). The duration of breastfeeding has been found shorter in urban areas than in rural areas, particularly in developing countries (Huffman, 1984). Jain and Bongaarts (1981) reported an inverse association of mother education with the duration of breastfeeding after controlling other socio-economic and demographic factors. An overtime declining pattern in the mean duration of breast feeding has also been found, but reaching to a point of near universal (Chayovan *et al.*, 1990; Popkin *et al.*, 1991; Anh *et al.*, 1995).

An analysis of birth interval data in the study of reproduction process is well documented as it offers rich and more detailed information for the analysis of reproductive behavior than do the data on the number of births (Henry, 1958). The analysis of birth interval data, for example, provides information on the progression from one parity to another as well as timing of this transition (Roderiguez and Hobcraft, 1980; Yadava *et al.*, 1992). In recent years, various types of birth intervals, namely, first birth interval, closed birth interval, open birth interval, straddling birth interval are widely used to estimate the level of fecundability (probability of conception in one menstrual

cycle) as well as for detecting current changes in fertility patterns of women (Sharma and Mishra, 1978; Yadava *et al.*, 1993). A number of studies have been conducted on differentials and determinants of these birth intervals in different regions of developing as well as developed countries (Kumar and Upadhya, 1999; Roy, 1991; Singh and Yadava, 1981; Yadava, 1989;Yusuf, 1985).

Total fertility rate (TFR) is considered to be a refined and reliable measure of fertility in a population. It measures the average number of children born to a woman in her reproductive life and it is independent of the age sex structure of the population. In developing countries, the estimation of fertility level becomes difficult due to incompleteness in birth registration data. Further census/survey data suffer from misreporting of ages, omission of births etc. The events are usually misreported partly due to memory bias and partly due to digit preference of the respondents. The lack of accurate registration of vital events and of accurate censuses of population has compelled demographers to develop alternative devices for estimating basic demographic parameters from inaccurate or incomplete data and consequently reliability has been increased on the scientifically designed sample surveys.

Population policy is becoming an integral part of a nation's development programs because increasing population growth tends to impose a strong constraint on the standard of living, happiness and even survival of the mankind. The challenge of controlling population growth to improve the socio-economic conditions of a society has inspired demographers to study the dynamics of population under various paths of maternity schedule (p(a)m(a)), where p(a) is the female population that survive to age a and m(a) is the probability that a female who is of age a will bear a female child in the next d(a) period of her life. Once the current schedule of fertility and mortality are known, some demographic theories/ population projection may provide an idea about the expected future change in population size and

structure. Replacement level indicates a level of fertility in which each generation of women exactly replaces the previous one and population growth reaches to zero at the end of the transition. However the success of population projection lies not only on the technique utilised but also on how far realistic assumptions are made relating to demographic parameters. A number of countries use transmigration programmed to reduce the population pressure at some of its particular region. For example, some inhabitants of Java go to Sumatra every year under an official transmigration programme and it has been a policy of the government for two thirds of the century. Under such a programme the amount of relief provided to Java however, depends on the age and volume of the migrants at the time of migration (Islam, 2001). The main objective of this research is to develop some demographic models and to discuss their applications. Consequently, some mathematical models on migration, birth interval, fertility and stable population theory have been developed and/or utilised. Applicability of models has also been tested with some real data sets. Some differentials and determinants of breastfeeding, birth intervals and fertility have also been discussed in relation to a number of socio-economic, demographic and cultural variables.

The thesis consists of six chapters. The present chapter is introductory which throws some light on the importance of this study and gives a brief literature review of the previous works and also outlines of the works done in subsequent chapters.

As stated earlier, a number of studies (Singh and Sharma, 1984;Singh and Yadava, 1981; Roy, 1991) on internal migration have highlighted the impact of migration on fertility reduction, which resulted due to husband-wife separation. Also those who were experiencing family migration have been reported to enjoy lower fertility due to changing attitude and behavior specially with respect to various socio-cultural determinants of fertility viz.; importance of adopting small family norm, value of children, diffusing strong

son preference, etc. In 1971 Census, 30.4 per cent of the total population was enumerated outside the place of birth, while the corresponding figures in 1981 and 1991 were 30.7 and 30.2 per cent respectively. Though these figures imply the static nature of spatial mobility in India during 1971-91, but the redistribution of population through internal migration is important in the study of change at the local and national level because it is a central aspect of such systematic processes of urbanization, industrialization, and regional differentiation of economic growth.

Keeping these aspects in view, which is not limited up to socio-economic and cultural development, a number of previous studies (Bhatt, 1986; Kadi and Sivamurthy, 1988; Singh and Yadava, 1974) have attempted to explain the migration phenomenon through behaviouring parameters of the process by formulating and applying different types of migration models. In chapter II, an attempt has been made to analyse the propensity of migration from/to different Indian states and also the variation in inter-state migration probabilities over the past two decades through a probabilistic model. The specific objectives of this chapter are: (a) to study the variation in migration pattern in India over a period of last three decades, (b) to analyse the reasons of migration and changes observed in some predominant regions among different migration streams, and (c) to estimate inter state migration flows among major states of India during the period 1971-81 and 1981-91.

Trends and differentials in fertility level of a particular community are governed by a composite result of the interaction of intermediate variables, leading to a variation in the change of conception and live birth. The important intermediate variables viz.: marriage, contraception, fetal loss and prevalence of the pattern of breastfeeding, together with the length of the post partum infertility period and hence the birth interval (Bongaarts, 1978; Davis and Blake, 1956; Jain *et al.*, 1979 and Srinivasan *et al.*, 1989). Further, all these intermediate variables, within a given length of birth interval, have varying effects on fertility depending on several socio-

economic, demographic, and cultural characteristics of the mothers (Bhattacharya *et al.*, 1987, 1994; Nath *et al.*, 1994). A number of studies have shown an inverse relationship between education and fertility (United Nations, 1983) and the role of education is associated significantly with lowering fertility (Afzal *et al.*, 1976), completed family size (Khan and Sirageldin, 1979), and the number of children ever born (Casterline, 1983). Impacts of literacy transition and female nuptiality, and female employment on fertility have also been studied by a number of authors (Sathar and Kaji, 1989; Mohamood and Khan, 1985). Education provides women the potential to improve their health and lives as well as those of their children and other family members (Bourne and Walker, 1991). Vlassoft (1991) finds education even more important than income or occupation in fertility reduction. Education also helps women to realise the advantages of having small families and various family planning practices to realise them (Pritchett, 1944).

The fertility differentials do exit by cultural and historical (Axelrod, 1990; Basu, 1993) and political contexts (Obermeyer, 1992). Indeed, differences in socio-economic progress, and personal and psychological motivations are known to be significant causes of fertility differentials (Mahmood, 1992; Gretter and Molyneaux, 1994). However fertility is affected by a number of interrelated factors. An examination of bivariate relations between selected demographic and socio-economic variables and fertility is important. In chapter III, an estimate of the fertility level in terms of the mean number of children ever born based on the birth histories of ever-married women has been provided. Differentials and determinants of fertility are also studied according to a number of socio-economic, demographic and cultural variables through a multiple classification analysis (MCA).

As said in the beginning, a birth interval is a mixed and complicated result of biological (fecundity, post partum amenorrhoea) and sociological (breastfeeding, abstinence, cultural and religious taboos) factors

(Bhattacharya *et al.*, 1987; Nath *et al.*, 1994). Stochastic models specific to age or marital duration of woman have been some of the important tools for the analysis of birth interval data (Pathak and Pandey, 1993;Sheps and Menken, 1973; Yadava *et al.*, 1992,1999). Life table technique has also been used to analyse such data (Rodriguez and Hobcraft, 1980; Nath *et al.*, 1994;Yadava *et al.*, 2000). As mentioned earlier, among various types of birth intervals, first birth interval and last closed birth interval play an important role to describe the characteristics of a couple particularly in relation to the level of fertility in the beginning and in the middle of their married life. Chapter IV deals with differentials and determinants of first birth interval and last closed birth interval according to a number of socio-economic and demographic characteristics of mother. The first birth interval has been studied in regard to the last child, and the last closed birth interval is studied in regard to the last but one child.

Long breastfeeding is a cultural practice and in most of the cases it continued till the occurrence of the next pregnancy (Chen *et al.*, 1974). In a society where prevalence rate of contraception is low, duration of breastfeeding plays an important role in reducing fertility (Bongaarts and Potter, 1983; Habicht *et al.*, 1985; Santow, 1987). Breastfeeding provides a natural method of delaying pregnancies at least for the first six months after a birth (Kennedy *et al.*, 1989). It enhances the duration of child spacing and hence increases the probability of child survival (PRB, 1999). A number of studies (Chowdhury *et al.*, 1997; Guz and Hobcraft, 1991; Mannan and Islam, 1995; Nath *et al.*,1994; Nessa *et al.*,1987; Popkin *et al.*, 1991; Singh *et al.,* 1993; Thapa and Williamson, 1990; Yadava *et al.*, 1998) have identified education, occupation, religion, availability of supplementary foods etc. as some of the important determinants of the duration of breast feeding.

However, differentials and determinants of the duration of breastfeeding discussed in numerous studies have shown that an accurate estimate of trends in breastfeeding is not straightforward. Studies conducted in different

parts of the world, at different points of time, are not comparable as they vary in questions asked, birth order taken, and methodology of analysis used (Trussell *et al.*, 1992). In chapter V, some differentials and determinants of the duration of breastfeeding have been studied according to various characteristics of mother and child. Life table and proportional hazard model techniques have been used for this purpose. In all the studies, either the 'retrospective' reporting or the 'current status' reporting of the breastfeeding (BF) data has been used. In the present study, both of these data have been utilised for studying the levels and differentials in the duration of the BF. The retrospective reporting in this survey refers to asking the mother her duration of the BF subsequent to the birth of her last but one child, whereas the current status reporting entails noting mother's BF status at the survey date following the birth of her last child. The variation in the level of the duration of breastfeeding between 'retrospective' and 'current status' data has also been discussed.

Population projection models under stability and stationary conditions are getting due importance and have created a point of interest among planners and demographers due to its simplicity in derivational aspect. A population (closed to migration) under unchanging pattern of fertility and mortality schedules over a long period of time approaches to a stable population with a fixed age structure and its size increases with a constant growth rate. If growth rate is zero, the population is called stationary population. Lotka (1939) initiated the formulation of models for such populations with the help renewal equations. Recently, a number of attempts have been made to predict future population size for varying paths of reduction in fertility schedule under stability conditions (Cerone, 1996; Frauenthal, 1975; Keyfitz, 1971; Mitra, 1976; Singh *et al.*, 1981b; Yadava, 1985; Yadava *et al.*, 1989, 1996). However, it is difficult to keep a society/ country (specially in developing countries) closed to migration for a long time because movement is inevitable for its development. Keyfitz's (1975) work might be considered as a milestone to study the interrelationship between migration and

population growth under stability conditions. He considered migration to have similar effects on population like sterilization, implementation of the temporary contraceptive family planning methods or death. Moreover, if a continued stream of out-migration/ emigration of a certain proportion of persons is made for a long time then eventually population is re-established (Keyfitz, 1975). Chapter VI has discussed the impact of emigration/out-migration on various demographic measures. This chapter is divided into two sections. In the first section impact of emigration is looked on the birth trajectory and hence on the population size while section second deals with the derivation of some demographic measures viz. the proportion of the cohort that emigrates and dies at the destination, expectation of life, net reproduction rates, average age etc. in the presence of migration. The proposed expressions are also illustrated with some reasonable values of the demographic parameters.

The challenge of balancing socio- economic development and population growth inspired demographers and policy makers to study dynamics of population and its size in future. The process of obtaining future size of population on the basis of current rates is known as projection or prediction of population. It is an analytical tool to experiment with demographic process for better understanding of the future size of population. It is based on some realistic assumptions on trend and pattern of demographic parameters, which will occur during socio-economic and demographic change. However, the success of projection lies not only on the technique of population projection but also on how far realistic are the assumptions relating to the demographic factors affecting the size and growth of population in the future years to come. Needless to mention that the projection process plays a vital role in the national planning and no planning of resources are complete without knowledge of the size of population growing over time. Taking all these aspects into considerations, Chapter VII will be devoted to develop some models for the future population growth under stability conditions.

Most of the chapters of this thesis are based on the data collected under a sample survey entitled "Effect of Breast feeding on Fertility in Rural Northern India" sponsored by the Rockefeller Foundation, USA, during 1995 under the auspices of the Centre of Population Studies, Department of Statistics Banaras Hindu University (for details about the data see Appendix in the last of the thesis also the Chapter III). In chapter II some secondary sources of data based on Indian censuses have also been utilised.

CHAPTER - II

CHAPTER-II

TRANSITION IN MIGRATION TRENDS

2.1 Introduction

In developing society/country where disparities exists in almost all respect of socio-economic, demographic, cultural and political circles, migration is of prime importance and it is bound to occur. Looking at its association with brain drain and also as a policy to population control, it is still one of the least researched demographic topic (Keyfitz, 1975; Mitra, 1988). This occurs to a large extent due to difficulties involved in the collection of qualitative data. However, a number of social scientists as well as policy makers have recognised the importance of studying migration and it has got its due position in demographic transitions.

As mentioned in the introductory chapter, migration particularly in rural areas of developing countries plays an important role in changing the socio-economic and cultural environment of the people and may have an important bearing on them (Premi, 1984; Singh, 1998 and Skeldon, 1986). For example, rural to urban migration can be shown captured under three broad heads: resources flow, information flow and flow of trained manpower. In most of the developing countries including India, majority of the people move due to push factors rather than pull factors. Consequently, they migrate to different destination places singly, at least in the beginning, leaving their dependants behind in the rural areas. Such a phenomenon of migration, infact, acts as a strong catalyst for a constant interaction with their family members at the origin places either in terms of visiting for a short interval or by sending remittances to them for their survival.

A number of earlier studies (Roy, 1991; Singh and Sharma, 1984; Singh and Yadava, 1981) on internal migration have well documented and highlighted

the impact of migration on fertility as a result of husband-wife separation due to migration. On the other hand, family migration (people who migrate with their wives) have also been reported to enjoy lower fertility due to changing attitude and behaviour specially with respect to various socio-cultural determinants of fertility viz.; importance of adopting small family norm, value of children, diffusing strong son preference, etc. The importance of migration studies has increased its domain in the context of health transition and emerging health issues for the urban as well as rural areas during the past one decade with increasing incidence of STD, HIV/AIDS. It has gained wider importance in view of nature and pattern of increasing HIV infection among innocent housewives in rural areas particularly whose husbands have been migrated to different urban centres. Though spatial mobility in India has been considered static in nature, absolute number involved in internal migration has been large than many developed and developing countries (Yadava, 1988; Zuchariah, 1964). The redistribution of population through internal migration is important to study the changes at the local and national level as it provides systematic processes of urbanisation, industrialisation and regional differentiation of economic growth.

A number of studies (Bhatt, 1986; Kadi and Sivamurthy, 1988; Singh and Yadava, 1974) have attempted to explain the process of migration through behavioracing parameters by formulating and applying different types of migration models. Migration models explaining the volume and direction of migrants give an idea about the number of migrants going to different places from a single area or to a single place from different places. Revenstein (1885,1889) established some migration hypotheses, which included an inverse relationship between the volume of migration and distance. In 1946 Zipf formulated a gravity type mathematical model assuming the number of migrants from one place to another as directly proportional to the product of the populations of two included places and inversely proportional to the distance between them. Mathematically,

$$M_{ij} = \frac{P_i P_j}{D_{ij}} \qquad \text{........(2.1)}$$

Where M_{ij} denotes the number of migrants from place i to j, P_i and P_j are the populations of the place i and j respectively, and D_{ij} is the distance between i and j. Several studies, however have shown a less effect of distance on migration flow (Bogue and Thampson, 1949; Claeson, 1968; Hangerstrand, 1957; Levy and Wadycki, 1973; Rose, 1958; Tere Heid, 1963).

Stouffer (1940) introduced ideas of opportunities and intervening opportunities in migration process. He suggested that there is no necessary relationship between migration and distance, but according to him number of migrants is directly proportional to the number of opportunities available at the place of destination, and inversely proportional to the number of intervening opportunities between the place of origin and destination. His model is

$$\frac{\Delta Y}{\Delta S} = \frac{a.\Delta x}{x.\Delta s} \qquad \text{.........(2.2)}$$

Where Y is the number of persons moving from origin to a circular area of width s, x is the cumulated number of opportunities between origin and destination, x is the number of opportunities within the area of width s and a is a constant.

Nevertheless, difficulties arise in applying Stouffer's theory, as there exist problems in defining opportunities and intervening opportunities. Stouffer (1960) himself concluded that his theory failed to provide any greater understanding than provided by gravity models. Further, various attempts have been made to modify the numerator *i.e.*, distance or intervening opportunities (Anderson, 1955; Johnston, 1971; Tere Heid, 1963) and the

denominator *i.e.*, population or opportunity factors (Hangerstand, 1957; Stewart, 1941; Strodbeck, 1949).

Later some researchers used 'prior migrants' as an independent variable to explain the current flow of migration (Greenwood, 1971; Levy and Wadychi, 1973; Peterson, 1958; Singh and Yadava, 1974 and 1979; Sivamurthy and Kadi, 1984; Traver and McLeod, 1973). According to them gravity type models along with the variable 'prior migration' are found to be more capable for predicting the volume and direction of current flow of migration particularly in developing countries.

In this chapter an attempt has been made to analyse the propensity of migration from/to different Indian states and also the variation in inter state migration probabilities over the past two decades through a probabilistic model. The specific objectives of this study are: (i) to study the variation in migration pattern in India over a period of last two decades, (ii) to analyse the reasons of migration and changes observed in some predominant regions among different migration streams, and (iii) to estimate inter state migration flows among major states of India during the period 1971-81 and 1981-91.

2.2 Data and Methodology

2.2.1 Profiles of Indian States

Based on the Indian census (1991) and the National Family and Health Survey (NFHS) (1992-93), some demographic and socio-economic scenario of different states and union territory of India are briefly described as below:

The total fertility rate is observed higher for the Northern Indian states Uttar Pradesh (UP), Rajasthan, Bihar, Haryana and Madhya Pradesh (MP) and lower for the states of South and West zones and also for the states Punjab,

Orissa, West Bengal, Manipur, Mizoram and Tripura. The mean ideal number of children was more than 3 for the North and Northeast states except Tripura. A lower singulate mean age at marriage (less than 20 years) was observed for the states MP, UP, Haryana, Rajasthan, Bihar, WB, Maharashtra and Andra Pradesh, while it was higher (about 25 years) for the states Goa and Manipur.

Infant mortality rate (IMR), an indicator of the health status of a community, showed a wide variation among the states, from nearly 15 to 112. The IMR was found significantly lower for the states Mizoram (14.6), Nagaland (17.2), Kerala (23.8), Goa (31.9), Arunachal (40.0), Manipur (42.4), Jammu (45.4) and Maharashtra (50.5) and remarkably higher (75 or more) in the states of UP (97.9), MP (85.2), Bihar (89.2), Orissa (112.1) and West Bengal (75.3) than the national level.

Any notable change has not been observed in the position of the states in terms of population size during 1981 and 1991. Like in 1981, UP contributed highest proportion (16.4%) of total population of India, followed by Bihar (10.2%) and Maharashtra (9.3%). However, the population density was high in the union territory Delhi followed by Chandigarh, Lakshadweep and Pondichery in both the years 1981 and 1991. The sex ratio (females per 1000 males) was higher for the states of Southern zone and also for states like Himachal Pradesh and Manipur. The proportion of females was quite low for Chandigarh, Andaman & Necubar Islands and the capital Delhi.

The literacy rate was satisfactorily higher (more than 75) for the states Kerala, Mizoram, Lakshadweep, Chandigarh, Goa and Delhi in 1991 as compared to the rate found at the national level (52.1). The rate was remarkably low for the Northern states Bihar, Rajasthan, Arunachal, UP and MP. The literacy rate was significantly higher for males as compared to females in all the states.

The literacy rate of ever married women aged 13-49 was observed to be remarkably higher in Mizoram (91.6%) and Kerala (84.0%). The proportion of illiterate married women was found high (more than 60%) in the states Haryana, Rajasthan, UP, MP, Bihar, Orissa, Arunachal, Andra and Karnataka. In India about 11 and 6 percents people belonged to Muslim and other religion respectively while rest were Hindu. However, a lot of variation prevailed over the states. Concentration of Muslim community was more in UP, WB and Assam and less in Orissa, Himanchal Pradesh and Punjab. The details about the characteristics of the Indian states may be seen from the Appendix Tables 2.1and 2.2. The migration data used here are taken from the 1971,1981 and 1991 censuses of India classified on the basis of place of birth, place of last residence and duration of stay at the place of enumeration.

2.2.2 The Model

In order to find the estimate of transition probabilities of migration for the major states, a model given by Kadi (1986) has been applied. The model given by Kadi (1986) is, infact, a modified form of Isserman *et al.* (1985) model and according to them, the migration flows between origin (i) and destination (j) is given by

$$P_{ij}(t) = \frac{M_{ij}(t)}{P_i(t-1)} = \frac{M_{ij}(b)\left[\frac{A_j(t-1)}{A_j(b-1)}\right]^r}{\sum_k M_{ik}(b)\left[\frac{A_k(t-1)}{A_k(b-1)}\right]^r} \qquad \text{.........(2.3)}$$

Where

$P_{ij}(t)$ = Migration Probabilities between i and j during the period (t-1, t),

$M_{ij}(t)$ = No. of persons moved from state i to state j during the period (t-1,t),

$P_i\,(t\text{-}1)$ = Population in state i that survive to year t which is

$$= \sum_k M_{ik}(t) \qquad k = 1,2,3,.......n.$$

Where k refers to the complete set of regions including i and j.

$A_j\,(t\text{-}1)$ = Attractive index of state j at time (t-1), and

$A_k\,(b\text{-}1)$ = Attractive index of state k in the base year (b-1).

The magnitude of migration response to change relative attractiveness is represented by the parameter r. It is a close approximation to an elasticity measuring the percentage change in migration probabilities to j for each percentage change in j's relative attractiveness. They used 'A' to represent factors that lead to changes in rates and referred to loosely for the time being as an "economic attractiveness" index. They used change in the employment index as a proxy to this.

Kadi (1986) modified the above model by replacing Aj (t-1) by Sj (t) *i.e.*, total number of stayers among past migrants at the destination state j during the period of current flows, which determines the current flow of migration. Sj (t) represents a better composite index of attractiveness because the size of Sj (t) is determined by the socio-economic and geographic factors prevailing at the destination state j during the period of current flow of migration. The model is:

$$P_{ij}(t) = \frac{M_{ij}(t)}{M_i(t-1)} = \frac{M_{ij}(b)\left[\frac{S_j(t)}{S_j(b)}\right]^r}{\sum_k M_{ik}(b)\left[\frac{S_k(t)}{S_k(b)}\right]^r} \quad i\#j \;\&\; i\#k \quad i,k = 1,2,3....n \qquad ......(2.4)$$

Where

$M_{ij}\,(t)$ = No. of persons moved from state i to state j during the period (t-1, t).

$M_{ij}\,(b)$ = Number of persons moved form state i to state j during the period (b-1, b).

$M_{i.}(t\text{-}1)$=Total number of persons moved out from state i to other states during (t-1, t).

$S_{.j}(t)$ = Total number of migrants at destination j with duration of stay (10+) years at the time t census counts (*i.e.*, stayers among past migrants).

$S_{.j}(b)$ = Total number of migrants at destination j with duration of stay (10+) years at the time b census counts.

This model gives changes in every migration probability with change in the attractiveness of anyone of the region. Here all transition probabilities are interdependent. Substituting all the available information and assuming r = 1, the migration probabilities for the decades 1971-81 and 1981-91 are estimated and presented in tables 2.3 and 2.4 respectively.

2.3 Results and Discussions

Table 2.1 shows the lifetime migration streams for India since 1971 by different types of move and distance. The proportion of rural to rural migration has substantially declined from 70 per cent in 1971 to 67.2 per cent in 1991, while the proportion of other migration streams (except rural to urban which is slightly declined in 1991 in comparison to 1971 and 1981) has increased over time. It is interesting to note that proportion of short distance migration has decreased over the period. Nevertheless, the numbers of districts during these twenty years have increased tremendously and this might have affected the distribution of migrants by distance. It should be mentioned here that from Assam (1981) and J.K. (1991) in-migrants were excluded where as out migrants were included in their respective year of census data. These might have increased the number of inter- state migrants also. It is evident form the table that overall rural to rural male migration has decreased from 1971 to 1991 (i.e., it was 53.2, 45.6 and 43.4 per cents respectively in 1971, 1981 and 1991), while the percentage of female rural to rural migration comprised majority of the shares in all types of

migration, which decreased in 1981 (73.3 per cent) with respect to 1971 (77.6 per cent) where as it again increased in 1991(76.5 per cent). Among rural to urban male migration, a gradual increasing trend has been noticed (26.6, 30.0 and 31.6 per cents in 1971, 1981 and 1991 respectively). In case of rural to urban female migration in 1981 (12.5 per cent), it was increased by 1.8 per cent compared to 1971 (10.7 per cent) and in 1991, it decreased (8.4 per cent) by 4.1 per cent with respect to 1981. Urban to rural and urban to urban migration didn't show any significant role and had a very low share in comparison to other streams of migration, but it substantially increased in both male and female migration during 1971 to 1991. A distance wise analysis of migration noted that intra district (short distance) migration has had largest share of 65.8, 61.8 and 59.5 per cents respectively in 1971, 1981 and 1991 as compared to inter district (medium distance) and inter state (long distance) migration. In short distance migration, rural to rural migration stream, though it decreased in 1991 and 1981 with respect to 1971 (54.5, 48.9 and 50.0 per cents respectively in 1971, 1981 and 1991), was the most dominant among the other three streams. In inter district (medium distance) and inter state (long distance) migration, rural to rural migration stream among females and rural to urban migration stream among males were found dominant streams of migration. Inter state rural to urban male migration has had increased to 8.8 per cent in 1991 from 8.1 per cent in 1971. Similarly in inter district rural to urban male migration, it has increased to 11.4 per cent in 1991 from 9.1 per cent in 1971.

In the last two censuses *i.e.*, in 1981 & 1991, an attempt has been made to collect information on the reasons for migration broadly categorised as employment, education, marriage, family moved and other reasons. The percentage distribution of each type of migration stream by reason and sex for the years 1981 and 1991 is presented in table 2.2. It can be seen that in both the years male migrated mostly for employment (32.0, 27.8 per cents in 1981 and 1991 respectively) and female migrated because of marriage (73.0, 77.0 per cents in 1981and 1991 respectively). In case of males, it

appears that the percentage of male migration due to family movement declined from 30.0 per cent in 1981 to 26.5 per cent in 1991, while their movement due to other reasons increased from 29.0 per cent in 1981 to 37.0 per cent in 1991. It is clear that among males, the main reason for short distance migration in 1981 was due to other reasons (35.2 per cent) which increased in 1991 (43.5 per cent). Second main reason of migration among males was due to family moved but it shows declined trends from 1981 (32.4 per cent) to 1991 (27.2 per cent). If we look on the situation in case of medium and long distance migration, employment was reported to be the main reason for male migration in 1981 (37.9 per cent and 50.5 per cent for short and long distance respectively). The corresponding figures were 34.1 and 43.5 per cents in 1991, slightly less than 1981 but still high in comparison to other reasons in 1991. It may be noted that male migration for intra district was maximum for family moved (32.4 per cent in 1981 and 27.2 per cent in 1991). Similarly, for male migration in inter district, employment was found to be maximum (37.9 per cent in 1981 and 34.1 per cent in 1991). There was a declined proportion of male inter district migration for education during the period (1971-1991) for all types. The proportion of rural to urban male migrants for employment increased from 27.6 per cent in 1981 to 41.5 per cent in 1991 whereas such proportion declined from 50.4 per cent in 1981 to 44.1 per cent in 1991. Family moved was an important factor for male migration in 1981 and 1991 *i.e.*, the proportion of such movement was 32.4 per cent, 29.9 per cent and 24.3 per cent for intra district, inter district and inter state migration in 1981, and 27.2, 27.1 and 23.7 per cent respectively in 1991. The proportion of male migrants due to marriage was very small in both the censuses. For example it was 1.1 and 1.7 per cent in case of inter state migration in 1981 and 1991 respectively. A rapid increase in proportion of rural to urban male migrants was observed for employment (from 27.6 per cent in 1981 to 41.5 per cent in 1991).

Among various reasons, marriage was found to be most important factor for female migration in all intra district, inter district and inter state migration

streams. The proportion of female migration due to marriage in 1981 census was 78.2, 66.4 and 53.6 per cents in intra district, inter district and inter state migration respectively. In 1991 these proportion were increased up to 81.1, 72.2 and 60.2 per cent correspondingly. However, the pace of change of female marriage migration was found to be higher in case of inter state migration as compared to others. The variation in female migration during 1981 and 1991 for education was found to be negligible. Surprisingly, the proportion of female migration for employment was also found to be declining for all intra district, inter district and inter state types of migration during this period (Table 2.2). The other reason of female migration did not show any consistent change over the period.

The transition probabilities for inter state migration during 1971-81 and 1981-91are given in table 2.3 and table 2.4 respectively. For example, the probability of inter state migration from Karnataka to Andhra Pradesh was 0.2 (=0.21) in 1971-81 which was declined to 0.2 (=0.17) in 1981-91. Similar interpretation may be made for other figures. For a better understanding, the probability value of each state is converted to respective percentage. From earlier studies, it is shown that the states such as Gujrat, Maharashtra, West Bengal and Madhya Pradesh had experienced larger proportion of inter state in-migrants. In case of Gujrat it was noticed that there was increased percentage of in-migrants from all the major states during 1971-81 and 1981-91. A larger proportion of increase was from Orissa (0.8 per cent in 1971-81 and 5.4 per cent in 1981-91) followed by Madhya Pradesh. Andhra Pradesh shared a high percentage of in-migrants from Karnataka in 1971-81 (21.0 per cent) and declined slightly in 1981-91(18.0 per cent). It was maximum 19.0 per cent from Tamil Nadu in 1981-91. The largest percentage of increase in in-migrants to Madhya Pradesh was from Bihar (7.2 per cent in 1971-81 and 19.8 per cent in 1981-91) followed by Orissa. In West Bengal, a larger percentage of in-migrants was from two neighbouring states Bihar and Orissa with a substantial decrease during the period 1981-91 compared to 1971-81. Uttar Pradesh, a biggest state of India in population size, recorded

an increase in in-migrants from Bihar (17.1 per cent in 1971-81 and 18.2 per cent in 1981-91) and West Bengal (9.0 per cent in 1971-81 and 12.8 per cent in 1981-91) where as Tamilnadu has observed a large in-migrants from Kerala (40.0 per cent in 1971-81 and 31.7 per cent in 1981-91) followed by Karnataka (14.5per cent in 1971-81 and 9.7per cent in 1981-91). Punjab has received some in-migrants from Haryana followed by Uttar Pradesh and Rajasthan. However, Bihar State has contributed a largest percentage change (0.8 per cent in 1971-81 to 5.2 per cent in 1981-91) in in-migrants to Punjab during 1981-91. There was a declined trend of in-migrants from all states to Orissa during 1981-91. The largest percentage change in-migrants was noticed from states of Bihar, Andhra Pradesh and Madhya Pradesh.

The estimated result of in-migration, out-migration and net migration for major states of India during 1971-81 and 1981-91 may be grouped as follows:

Group I: (In-migrating states in 1971-81): Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Punjab and West Bengal.

Group II: (In-migrating states in 1981-91): Gujarat, Haryana, karnataka, Madhya Pradesh, Maharastra, Punjab and West Bengal.

Group III: (Out-migrating states in 1971-81): Andhra pradesh, Bihar, Kerala, Rajasthan, Tamil Nadu and Uttar pradesh.

Group IV: (Out-migrating States in 1981-91): Andhra pradesh, Bihar, Kerala, Orissa, Rajasthan, Tamil Nadu, and Uttar pradesh.

From this grouping, it is clear that the basic structure of inter state migration remained same during both the decades 1971-81 and 1981-91 *i.e*, all the states given in group I retained the states of in-migrating states in 1981-91 except Orissa (Table 2.5). This may be due to the fact that the states of this category such as Gujarat, Maharashtra, and West Bengal are industrially developed as compared to other out-migrating states. The volume of in-migration to Gujarat and Maharashtra had substantially larger as compared

to other in-migrating states. This indicates that the industrial development is one of the major factors of inter state migration in India. The states Orissa and Madhya Pradesh had shown as in-migrating states during 1971-81 probably because of development of towns/cities, and low cost of living that would have attracted migrants from neighbouring states.

The III & IV groups reflect out-migration from major states during the periods 1971-81 and 1981-91. It was found that Andhra pradesh, Bihar, Kerala, Rajasthan, Tamil Nadu and Uttar Pradesh remained as out-migrating states during both the inter censal periods (Table 2.5). One of the probable causes of these out-migrating states would be their industrial backwardness. Bihar, Rajasthan and Uttar Pradesh with low status of social and economic development had experienced large volume of out-migration. Where as Kerala and Tamil Nadu even with higher social development (literacy, infrastructure, health facility and so on) had also experienced similar pace of out-migration. The only exceptional state is Orissa which had shown in-migrant state in 1971-81, was now out-migrant state in 1981-91. This probably may be due to industrially backwardness, natural calamities like droughts/ floods, low agricultural development and growth of labour force in Orissa.

2.4 Conclusions

This study first highlighted the changing pattern of sex-wise lifetime internal migration streams in India by making use of 1971, 1981 and 1991 census data. In all the three censuses, rural to rural migration was prominent migration stream in India for each of the sex among all the four types of migration streams with a slightly declining trend from 1971 to 1991. Nevertheless, rural to urban migration stream was dominated by males in inter district and inter state migration which was, of course, declined in 1991 as compared to 1971 and 1981. Among females, majority belonged to rural to rural migration flow irrespective of distance. Male migration was mostly for

employment while female migration was marriage dominated. The proportion of both male and female migrants for education is found to be declined for all types of migration during 1981 and 1991 census. Similar observations was for family moved migration for various streams of intra district, inter district and inter state migration. Further rural to urban migration of males for employment was maximum where as rural to rural migration was predominant by female for marriage migration. It was found that during 1981-91, the states Maharashtra and Madhya Pradesh were continued to occupy the 1st and 2nd place among the in-migrating states, while the states Uttar pradesh and Bihar occupied 1st and 2nd place among the out-migrating states during both the periods. An interesting observation came from Orissa where the state was gaining population in 1971-81 was now in loosing group of states during 1981-91.

Table 2.1: Lifetime Migration Streams in India (Percentage Distribution), 1971, 1981 and 1991

Migration streams	1971			1981			1991		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
I. Intra-District (Short distance)									
R-R	38.1	61.9	54.5	31.3	56.1	48.9	30.3	57.7	50.0
R-U	9.4	5.2	6.5	10.7	5.8	7.2	11.4	0.7	3.7
U-R	3.2	2.9	3.0	3.4	3.0	3.1	3.5	3.0	3.2
U-U	2.5	1.5	1.8	3.6	2.1	2.6	3.7	2.2	2.7
Sub-Total	53.2	71.5	65.8	49.0	67.0	61.8	48.9	63.7	59.5
II. Inter-District (Medium Distance)									
R-R	10.1	12.2	11.6	10.1	13.8	12.7	9.3	15.2	13.5
R-U	9.1	3.5	5.2	10.8	4.3	6.2	11.4	5.0	6.8
U-R	2.0	1.5	1.7	2.4	1.9	2.0	2.5	2.0	2.2
U-U	5.9	3.0	3.9	7.7	4.0	5.1	7.7	4.2	5.2
Sub-Total	27.1	20.2	22.4	31.0	24.0	26.0	30.9	26.5	27.7
III. Inter-State (Long Distance)									
R-R	5.0	3.5	3.9	4.2	3.4	3.6	3.8	3.6	3.7
R-U	8.1	2.0	3.9	8.5	2.4	4.2	8.8	2.7	4.4
U-R	1.2	0.6	0.8	1.2	0.7	0.8	1.2	0.7	0.9
U-U	5.4	2.2	3.2	6.1	2.5	3.6	6.4	2.8	3.8
Sub-Total	19.7	8.3	11.8	20.0	9.0	12.2	20.2	9.8	12.8
IV. All Streams									
R-R	53.2	77.6	70.0	45.6	73.3	65.2	43.43	76.5	67.2
R-U	26.6	10.7	15.6	30.0	12.5	17.6	1.6	8.4	13.9
U-R	6.4	5.0	5.5	7.0	5.6	5.9	7.2	5.8	6.2
U-U	13.8	6.7	8.9	17.4	8.6	11.3	17.8	9.3	11.7
Sub-Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Grand Total I, II & III	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Sources: (i) Census of India, 1971, Series-I, Part-II-D (I), Migration Tables

(ii) Census of India, 1981, Series-I, Part-V-A & B (I), Migration Tables

(iii) Extracted from Migration Tables D1 and D2 of India provided by the Registrar General and Census Commissioner, India, 1991

Table 2.2: Percentage Distribution of Migrants by reasons for Migration, India, 1981 and 1991

Type of Migration	1981										1991									
	Male Reasons of Migration					Female Reasons for Migration					Male Reasons for Migration					Female Reasons for Migration				
	Emplo yment	Educ ation	Family moved	Marri age	Others	Emplo yment	Educ ation	Family moved	Marri age	Others	Emplo yment	Educ ation	Family moved	Marri age	Others	Emplo yment	Educ ation	Family moved	Marri age	Others
Intra-District																				
R-R	15.9	4.7	33.5	6.3	39.6	0.8	0.4	7.6	82.8	8.4	12.4	4.7	27.0	7.3	48.6	0.8	0.5	4.9	85.4	8.5
R-U	35.4	11.5	27.6	1.8	23.7	3.5	2.8	24.6	57.0	12.1	31.8	9.0	26.2	3.0	30.0	3.6	2.4	20.1	61.9	12.0
U-R	21.8	3.3	32.1	2.7	40.1	2.6	0.9	18.3	61.7	16.5	15.7	2.9	29.8	3.3	48.3	2.2	0.8	14.4	64.4	18.2
U-U	31.0	4.7	35.8	1.4	27.1	3.8	1.9	32.8	45.5	16.0	25.4	3.9	29.4	3.0	38.3	3.8	1.6	22.9	52.9	18.8
Total	21.7	6.0	32.4	4.7	35.2	1.3	0.7	10.5	78.2	9.3	18.1	5.5	27.2	5.7	43.5	1.2	0.7	7.4	81.1	9.6
Inter-District																				
R-R	25.7	4.0	35.1	4.2	31.0	1.7	0.5	10.5	79.6	7.7	22.0	4.0	30.7	5.5	37.9	1.4	0.5	7.2	83.8	7.2
R-U	50.4	8.2	22.5	1.0	17.9	4.7	2.6	31.3	49.2	12.2	4.1	6.7	22.0	2.0	25.1	4.6	2.1	25.3	55.9	12.1
U-R	28.9	4.2	31.6	2.1	33.2	3.6	1.3	22.6	58.2	14.3	25.6	4.3	30.3	3.1	36.7	3.4	1.1	17.4	64.7	13.4
U-U	40.2	6.0	31.9	0.9	21.0	4.5	2.4	35.2	44.1	13.8	36.9	5.3	29.0	1.9	26.9	4.5	1.9	26.8	53.4	13.3
Total	37.9	5.9	29.9	2.1	24.2	2.9	1.2	19.4	66.4	10.1	34.1	5.3	27.1	3.1	30.4	2.7	1.0	14.5	72.2	9.6

Table 2.2: (Continued)

Type of Migration	1981										1991									
	Male Reasons of Migration					Female Reasons for Migration					Male Reasons for Migration					Female Reasons for Migration				
	Emplo yment	Educ ation	Family moved	Marri age	Others	Emplo yment	Educ ation	Family moved	Marri age	Others	Emplo yment	Educ ation	Family moved	Marri age	Others	Emplo yment	Educ ation	Family moved	Marri age	Others
Inter-state																				
R-R	37.8	2.1	31.3	2.8	26.0	3.7	0.5	15.5	71.5	8.8	32.8	2.3	27.6	3.5	33.8	2.7	0.5	11.5	77.5	7.8
R-U	61.4	4.0	18.0	0.6	16.0	5.6	2.0	37.3	42.0	13.1	61.8	3.4	19.3	1.1	24.4	4.5	1.4	34.2	48.6	11.4
U-R	33.3	2.9	28.7	1.4	33.7	4.8	1.6	27.9	50.4	15.3	30.7	3.5	27.3	2.0	36.4	4.2	1.2	22.5	59.3	12.8
U-U	48.9	4.8	26.8	0.8	18.7	5.0	2.4	37.9	41.2	13.5	41.5	4.2	26.3	1.3	26.7	4.3	1.6	32.5	49.3	12.3
Total	50.5	3.8	24.3	1.1	20.3	4.7	1.5	28.4	53.6	11.8	43.5	3.5	23.7	1.7	27.7	3.7	1.1	24.5	60.2	10.5
Total																				
R-R	19.7	4.3	33.7	5.6	36.7	1.1	0.4	8.5	81.7	8.3	16.0	4.3	27.8	6.7	45.2	1.0	0.5	5.6	84.7	8.2
R-U	27.6	8.3	23.3	1.2	19.6	4.3	2.6	29.0	51.9	12.2	41.5	6.7	22.9	2.2	26.8	4.1	2.1	24.4	57.5	12.0
U-R	26.3	3.5	31.3	2.3	36.6	3.2	1.1	20.9	59.1	15.7	21.7	3.5	29.5	3.0	42.3	2.2	1.0	16.4	63.9	15.9
U-U	40.6	5.3	31.2	1.0	21.7	4.4	2.3	35.3	43.7	14.3	35.9	4.6	28.1	1.9	29.436	4.3	1.8	27.5	52.1	14.4
Total	32.0	5.6	30.1	3.2	29.1	1.9	0.9	14.1	73.4	9.7	27.8	5.0	26.5	4.1	.5	1.8	0.8	10.7	77.0	9.7

Sources: (i) Census of India, 1971, Series-I, Part-II-D (I), Migration Table

(ii) Census of India, 1981, Series-I, Part-V-A & B (I), Migration Tables

(iii) Extracted from Migration Tables D1 and D2 of India provided by the Registrar General and Census Commissioner, India, 1991

Table 2.3: Inter state Migration Probabilities (1971-1981)

States	AP	BIH	GUJ	HAR	KAR	KER	MP	MAH	ORI	PUN	RAJ	TN	UP	WB	Total
AP	-	0.0112	0.0149	0.0022	0.3398	0.0090	0.0497	0.2686	0.1390	0.0028	0.0067	0.1275	0.0136	0.0149	1.00
BIH	0.0074	-	0.0068	0.0053	0.0034	0.0015	0.0722	0.0222	0.1196	0.0077	0.0092	0.0026	0.1708	0.5714	1.00
GUJ	0.0153	0.0111	-	0.0036	0.0146	0.0066	0.0683	0.6829	0.0098	0.0033	0.1410	0.0107	0.0205	0.0124	1.00
HAR	0.0072	0.0116	0.0135	-	0.0056	0.0017	0.0378	0.0419	0.0104	0.3563	0.3177	0.0038	0.1819	0.0107	1.00
KAR	0.2110	0.0032	0.0112	0.0017	-	0.0402	0.0077	0.5530	0.0024	0.0020	0.0071	0.1447	0.0129	0.0029	1.00
KER	0.0404	0.0127	0.0218	0.0027	0.2137	-	0.0402	0.2062	0.0152	0.0030	0.0110	0.4004	0.0202	0.0127	1.00
MP	0.0201	0.0442	0.0481	0.0086	0.0084	0.0044	-	0.3270	0.1282	0.0113	0.1677	0.0064	0.2033	0.0223	1.00
MAH	0.1302	0.0066	0.2722	0.0054	0.1864	0.0212	0.2377	-	0.0046	0.0112	0.0370	0.0345	0.0450	0.0079	1.00
ORI	0.1352	0.1291	0.0086	0.0022	0.0034	0.0030	0.2810	0.0257	-	0.0050	0.0042	0.0044	0.0146	0.3835	1.00
PUN	0.0120	0.0271	0.0145	0.3514	0.0080	0.0038	0.0535	0.0668	0.0112	-	0.1656	0.0059	0.2558	0.0244	1.00
RAJ	0.0162	0.0168	0.2042	0.1834	0.0222	0.0012	0.1953	0.1328	0.0086	0.0796	-	0.0139	0.0973	0.0286	1.00
TN	0.1912	0.0084	0.0148	0.0027	0.3422	0.2306	0.0166	0.1466	0.0098	0.0032	0.0075	-	0.0161	0.0102	1.00
UP	0.0089	0.1054	0.0475	0.1132	0.0065	0.0028	0.2053	0.2512	0.0098	0.0821	0.0846	0.0045	-	0.0779	1.00
WB	0.0354	0.4344	0.0185	0.0065	0.0104	0.0050	0.0873	0.0738	0.1777	0.0162	0.0301	0.0152	0.0894	-	1.00

Table 2.4: Inter state Migration Probabilities (1981-1991)

States	AP	BIH	GUJ	HAR	KAR	KER	MP	MAH	ORI	PUN	RAJ	TN	UP	WB	Total
AP	-	0.0059	0.0254	0.0041	0.4034	0.0127	0.0527	0.2469	0.0871	0.0033	0.0089	0.1262	0.0097	0.0139	1.00
BIH	0.0060	-	0.0158	0.0306	0.0047	0.0021	0.1980	0.0326	0.0738	0.0513	0.0185	0.0026	0.1823	0.3817	1.00
GUJ	0.0168	0.0046	-	0.0067	0.0210	0.0088	0.0794	0.6373	0.0064	0.0072	0.1704	0.0103	0.0220	0.0090	1.00
HAR	0.0044	0.0043	0.0142	-	0.0034	0.0012	0.0695	0.0180	0.0045	0.3912	0.3272	0.0014	0.1520	0.0085	1.00
KAR	0.1771	0.0015	0.0145	0.0024	-	0.1089	0.0074	0.5694	0.0020	0.0024	0.0094	0.0965	0.0058	0.0025	1.00
KER	0.0423	0.0078	0.0489	0.0090	0.2500	-	0.0533	0.2099	0.0087	0.0043	0.0220	0.3170	0.0177	0.0091	1.00
MP	0.0124	0.0205	0.0723	0.0189	0.0057	0.0053	-	0.3421	0.0832	0.0191	0.1949	0.0034	0.2078	0.0146	1.00
MAH	0.1034	0.0033	0.3592	0.0071	0.1680	0.0252	0.2087	-	0.0037	0.0110	0.0382	0.0273	0.0368	0.0081	1.00
ORI	0.1524	0.0958	0.0544	0.0073	0.0131	0.0058	0.3457	0.0450	-	0.0122	0.0144	0.0052	0.0213	0.2275	1.00
PUN	0.0083	0.0140	0.0174	0.4282	0.0067	0.0041	0.0500	0.0525	0.0062	-	0.2209	0.0042	0.1685	0.0190	1.00
RAJ	0.0137	0.0071	0.2380	0.2272	0.0194	0.0023	0.1875	0.0914	0.0050	0.0968	-	0.0124	0.0787	0.0205	1.00
TN	0.1629	0.0041	0.0248	0.0033	0.3632	0.2699	0.0167	0.1222	0.0048	0.0032	0.0096	-	0.0081	0.0072	1.00
UP	0.0058	0.0441	0.0696	0.1536	0.0063	0.0017	0.1980	0.2491	0.0056	0.1165	0.0922	0.0025	-	0.0551	1.00
WB	0.0336	0.3125	0.0319	0.0219	0.0154	0.0071	0.0884	0.0808	0.1490	0.0283	0.0868	0.0167	0.1275	-	1.00

Table 2.5: Inter state In-migration, Out-migration and Net migration 1971-81, 1981-91

State	1971-81			1981-91		
	*Inmigrants	Outmigrants	Netmigrants	*Inmigrants	Outmigrants	Netmigrants
Andhra Pradesh	450761	530005	-79244	364221	462040	-97819
Bihar	452186	1021718	-569532	239452	951822	-712370
Gujrat	460142	355914	104228	664824	278518	386306
Haryana	414295	330395	83900	597468	335653	261815
Karnatka	645515	638510	7005	656162	525888	130274
Kerala	194962	459319	-264357	250256	391953	-141697
Madhya Pradesh	870384	681934	188450	1012953	544583	468370
Maharastra	1699449	650203	1049246	1478960	707347	771613
Orissa	405137	227051	178086	236146	249731	-13585
Punjab	328029	312329	15700	469233	322706	146527
Rajasthan	516085	576808	-60723	583267	664117	-80850
Tamil Nadu	402420	582663	-180243	281001	563294	-282293
Uttar Pradesh	620609	1540362	-199753	546277	1588457	-1042180
West Bengal	864896	417658	447238	561750	355769	205981

Note: * Estimated from the model.

Appendix Table 2.1: Selected demographic characteristics, by state: India, 1992-93.

State	TFR	MINC	SMAM	IMR	Illiterate	Hindu	Muslim	Other
Andhra Pradesh	2.6	2.7	18.1	70.4	68.7	87.7	8.4	3.9
Bihar	4.0	3.4	18.0	89.2	78.3	82.1	15.7	2.2
Gujrat	3.0	2.6	20.2	68.7	55.3	89.5	8.5	2.0
Haryana	4.0	2.6	18.4	73.3	63.8	88.4	4.3	7.3
Karnatka	2.9	2.5	19.6	65.4	61.6	86.3	10.6	3.1
Kerala	2.0	2.6	22.1	23.8	16.0	58.3	19.1	26.6
Madhya Pradesh	3.8	3.1	17.4	85.2	74.4	93.0	4.9	2.1
Maharastra	2.9	2.5	19.3	50.5	50.0	77.3	11.1	11.6
Orissa	2.9	3.0	20.7	112.1	67.4	96.7	1.5	1.8
Punjab	2.9	2.6	21.1	53.7	52.6	39.7	1.2	59.1
Rajasthan	3.6	3.0	18.4	72.6	82.2	92.3	5.5	2.2
Tamil Nadu	2.5	2.1	20.5	67.7	50.1	88.1	5.4	6.5
Uttar Pradesh	4.4	3.4	18.6	99.9	75.7	82.9	15.8	1.3
West Bengal	2.9	2.6	19.2	75.3	50.6	77.2	20.7	2.1

TFR--Total Fertility Rate; **MINC**--Mean Ideal Number of Children; **SMAM**--Singulate Mean Age at Marriage; **IMR**--Infant Mortality Rate

Appendix Table 2.2: Indian States by population and density, 1981-91

States	Per cent to total Population		Density
	1981	1991	1991
Andhra Pradesh	7.86	7.84	241
Bihar	10.23	10.23	497
Gujrat	4.88	4.99	210
Haryana	1.93	1.89	369
Karnatka	5.31	5.43	234
Kerala	3.44	3.72	747
Madhya Pradesh	7.84	7.64	149
Maharastra	9.33	9.19	256
Orissa	3.73	3.86	202
Punjab	2.39	2.46	401
Rajasthan	5.20	5.01	128
Tamil Nadu	6.59	7.08	428
Uttar Pradesh	16.44	16.22	471
West Bengal	8.06	7.99	766

CHAPTER - III

CHAPTER-III

DIFFERENTIALS IN FERTILITY: A MULTIVARIATE ANALYSIS

3.1 Introduction

The reproduction process in human being typically occurs during teens of life through there is a variation in the age at menarche around the globe (Riley *et al.*, 1993). Fertility behaviour is changing over time and numerous studies have been done on it all over the world (Blacker, 1994; Diamond and Rutenberg, 1995; Vander Post, 1992). In developing countries, usually demographic data suffer by a variety of errors such as age mis-reporting or displacement of date of births, under reporting of births or omission of dead children (Brass, 1978). In developing countries, like India, unwanted population growth resulting from sustained high fertility and declining mortality has been contributing a major problem. Fertility rates have declined but these are still high. Differentials in fertility have been noted in respect to demographic, socio-economic, and cultural characteristics of mothers (NFHS, 1992-93, 1998-99). Thus, a precise study of determinants and differentials in fertility are important in any demographic analysis for a society.

A number of studies have shown an inverse relationship between education and fertility (United Nation, 1983) and the role of education are associated significantly for lowering fertility (Gertler and Molyneux, 1994). Education of wife has revealed a negative association with the completed family size (Khan and Sirageldin, 1979), and number of children ever born (Casterline, 1983). Education provides women the potential to improve their health and lives as well as those of their children and other family members (Bourne and Walker, 1991). Vlassoff (1991) finds education even more important than income or occupation in inducing fertility. Education also helps women to realise the advantages of having small families and adoption of various family planning practices (Pritchett, 1994).

Female's employment has also been found to have impact on fertility (Sathar and Kazi, 1989; Mohamood and Khan 1985). Though, a negative association between female work and fertility has been found in several developed countries, it has not always been clear and inverse in case of developing countries (Shah, 1986). Analysis of world fertility survey data by Rodriguez and Cleland (1981) revealed that in all Latin American and Caribbean Countries, urban fertility was lower than rural fertility but it was less pronounced in Asia and the Pacific. Husband's occupation in the modern sector was found to be negatively related to fertility (Alam and Casterline, 1984). Some other studies demonstrated a negative relationship between age at marriage and fertility (Alam *et al.*, 1985; Irfan and Foroog, 1984; Karim, 1974). Hakim (1994) using both bivariate and multivariate analysis, examined the effect of demographic and socio-economic factors on the level of fertility based on Pakistan data and found age at marriage as one of the most important variable explaining fertility. Similarly, Richard and Rao (1995) have studied the influence of age at marriage and family planning on fertility based on the data of Vellore district in Tamil Nadu. Using the analysis of variance and the multiple classification analysis, they have found a large differential in fertility over age at marriage compared to family planning acceptance.

The fertility differentials do exit by cultural and historical (Axelrod, 1990; Basu, 1993) and political contexts (Obermeyer, 1992). Indeed, differences in socio-economic status, and personal and psychological motivations are known to be the significant causes of fertility differentials (Mahmood, 1992; Gertter and Molyneaux, 1994). However, the human reproductive behaviour is the result of a complex trap of socio-economic, biological and cultural factors in which the factors themselves are found intricately related with each other. Nevertheless, a complex interactive link between the independent variables and a dependent variable in the study of human behaviour, such as fertility, enforce application of multivariate analysis techniques. The aim of this chapter is to estimate the fertility level in terms of the mean number of

children ever born based on the birth histories of ever-married women. Multiple classification analysis (MCA) is utilised to examine the effect of several demographic, socio-economic and cultural factors on the level of fertility.

3.2 Data and Methodology

3.2.1 Data used

The data utilised for this study have been collected from the rural areas of Varanasi, a district of Eastern Uttar Pradesh in Northern India. A retrospective survey entitled "Effect of Breastfeeding on Fertility in Northern Rural India- A Sample Survey- 1995" sponsored by the Rockefeller Foundation, USA, was conducted under the auspices of Centre of Population Studies, Department of Statistics, Banaras Hindu University. The main objective of the survey was to study the interrelationships among breast feeding, post portum amenorrhoea (PPA) and birth intervals to assess their linkages with fertility. The information from about 1022 households comprising 1351 couples completely enumerated from five villages has been obtained. Apart from the other questions, questions related to fertility, breastfeeding, PPA, family planning, opinion of females about breastfeeding, family size, etc. were asked. Women were asked separately about their number of daughters and sons who were still surviving and those who had died. Then more complete details from 1060 mothers about their *last birth*, and 767 mothers about their *last but one* birth were collected including the year and month of birth, sex and survival status of child, etc.

Uttar Pradesh is the most populous state in India and constitutes 16.4% of the total population of the country. Varanasi lies in Eastern Uttar Pradesh, which is a well-defined region in the middle Gangatic Plain. This region shares 29.2% of the State's total land area, and about 38% of its population (Census of India, 1991). The population growth rate as well as the fertility

and mortality rates for the region during 1981-1991 were above the state's average. The density of population for the region in 1991 was 614 persons per square kilometre as against 473 persons for Uttar Pradesh.

The culture of Eastern Uttar Pradesh is a product of a mixed heritage of Hindu and Muslim influences. Most of the people in the area have deep-rooted traditional values and their way of thinking and living are governed by the religious and cultural norms. The language of the people is Hindi, although a large percentage of the Muslim population speaks Urdu. About 88% of the population of Eastern Uttar Pradesh live in rural areas compared to 80% of Uttar Pradesh and 74% of India. The occupational structure of the workforce in Eastern Uttar Pradesh is heavily skewed in favour of agriculture.

Data collection was undertaken in five villages, which were randomly selected and were completely enumerated. The survey schedule included questions on the household composition, household facilities, and household belongings. Marriage, migration, fertility, morbidity, and mortality occurred in the households during specific periods in the past were recorded.

The technique of Multiple Classification Analysis (MCS), which is analogous to multiple regression analysis with 'dummy variables' has been applied to determine the net effect of each factor after controlling for the effect of other predictors and co-variates. MCA is a multivariate technique for examining the interrelationships between several predictor variables and a dependent variable within the context of an additive model. An advantage of MCA over other multivariate techniques is that it can incorporate predictor variables, which are interval, ordinal or nominal scaled. MCA deals not only with linear but also non-linear relationships among predictors and the dependent variables (Andrews *et al.*, 1973). The MCA model assumes that the dependent variable is predicted by the additive effect of the predictors. A

general form of the model (called as adjusted model) can be expressed by the following equation.

$$Y_{ij...n} = \overline{y} + a_i + b_j + ... + e_{ij...n} \qquad \text{......... (3.1)}$$

When, only one predictor is taken to know the effect of memberships in the ith category of the predictor A. The model is called as unadjusted MCA and the equation of this model becomes as

$$Y_i = \overline{y} + a_i + e_i \qquad \text{......... (3.2)}$$

Where,

$Y_{ij...n}$ is the score of individual n who falls in the ith category of predictor A, the jth category of predictor B etc.;

$\overline{y}$ is grand mean of the dependent variable;

a_i is the effect of memberships in the ith category of predictor A;

b_j is the effect of memberships in the jth category of predictor B;

y_i is the score of individual n who falls in the ith category of predictor A; and

e_i & $e_{ij...k}$ are the error terms.

The independent variables included in this study are:

3.2.2 Demographic variables

The duration of the breastfeeding (CBF - Combined breastfeeding - Full + Partial) and age at return marriage (AGERM).

CBF is measured in the completed months.

AGERM is measured in completed years. The AGERM is the age, at which a couple starts living together for consummation after a ceremony known as Gauna, which may be performed after several years of marriage.

3.2.3 Socio-economic variables

The variables included are: type of household (HHTYPE), status of house (HOUSE), main occupation of the household (OCCHH), economic status of the household (ECONHH), social status of the household (SOCIALHH), education of wife (EDUW), and education of husband (EDUH).

Except for education, the other variables in this group were computed at the household level. A household was defined as a group of persons who resided together and took food from a common kitchen, inclusive of persons who lived outside the village but claimed the household to be of their own. The inclusion of the household level variables in the rural context of the study area is considered appropriate as the behaviour of an individual is influenced by not only her/his characteristics alone but also by the characteristics of the household to which she/he belongs. People in the household take part in the economic and social activities together, share joys of social living, have strong feelings of mutual obligation during crisis and identify their interest with the household welfare.

The techniques of measurement of these above-mentioned socio-economic variables are discussed in the Appendix.

3.2.4 Cultural Variables

Two variables included are religion (RELIGION) and caste (CASTE). Religion is split into two categories as Hindus and Muslims. For measurement of these two variables see the Appendix.

The mean number of children ever born (MCEB) has been taken as a fertility measure and as such it is the independent variable.

Various statistics are computed through the MCA programme. The mean value for each category is calculated with deviations from the grand mean before and after adjusting for other predictors and co-variates. The multiple R provides a summary estimate of the overall relationship between predictors and the dependent variable, adjusted for the degree of freedom. The multiple R-Squared measures the total variation in the dependent variable explained by all the predictors and co-variates taken together adjusted for degree of freedom.

3.3 Results and Discussions

Tables 3.1 and 3.2 contain the results of the multiple classification analysis (MCA) and show the effect of several demographic, socio-economic variables on children ever born. The mean number of children ever born (MCEB) in the whole sample was 4.07. However, a much variation in MCEB was noted according to demographic, socio-economic and cultural variables. The detailed findings of MCA have been discussed in relation to these variables in the following sections:

3.3.1 Fertility and Demographic Variables

3.3.1.1 Fertility in relation to age at return marriage

Age at return marriage (AGERM) not only marks the entry into a sexual union and the beginning of exposure to child bearing but may also be an important gauge of women's status (Kazi and Sathar, 1986). A rise in age at return marriage from under 15 years to 16-18 years would probably produce an appreciable decline in fertility because women who marry at these ages will lose an appreciable amount of their fertility period and are not likely to

compensate for the loss (Agrawala, 1967). Obviously, if the age at marriage is early, a woman would have a longer exposure period and hence, it is expected to end up with higher fertility than those marrying at later stage (Coale, 1975). A decline in fertility due to rise in age at marriage has also been documented in various other studies (Alam and Karim, 1986; Hakim, 1994).

This study revealed a higher (5.04) mean number of children ever born (MCEB) to women of all age groups whose AGERM was less than 15 years than those who married at (15-17) years (4.15) or on 18 years and over (3.21). The MCA shows a significant effect of the age at marriage on the children ever born. The adjusted mean number of children ever born (AMCEB) was 4.63 (after adjusting for the other demographic and socio-economic factors) among women who married early i.e. before 15 years of age than (3.39) among those who married at 18 years or over.

3.3.1.2 Fertility in relation to breastfeeding

The importance of lactational amenorrhoea as a determinant of fertility has long been recognised because of frequent suckling which delays the return of ovulation. The unadjusted mean number of children ever born was found to vary from a low value of 3.60 among women who breast feed for less than 12 months than a high value of 4.58 for mothers who breast feed for 36 months or more. However, after controlling for the other demographic and socio-economic variables, the adjusted mean number of children ever born remained significantly higher for mothers who breast feed less than 24 months than those who breast feed for more than 24 months. The introduction of several socio-economic, demographic and cultural factors as controls makes little difference to the breastfeeding differentials.

3.3.2 Fertility and Socio-economic Variables

3.3.2.1 Fertility in relation to Education

As pointed out in the introductory section, education can affect fertility through numerous channels. Its effects include in delaying age at marriage, reduction in the desired family size, increased opportunities for personal advancement, awareness of social mobility and freedom from close familiarities leading to greater chance of employment of women outside the home and greater exposure to knowledge of and favourable attitudes towards family limitation (Cassen, 1976; Cochrane, 1979; Holsinger and Kasarda, 1976). Increased education is supposed to result in non-familial aspirations and a greater understanding of the process and ways of controlling fertility. A negative effect of education on the number of children ever born has been found and more significantly for those mothers who had secondary or higher levels of education (Casterline, 1983).

Obviously, this analysis indicated an inverse relationship of education with fertility. The unadjusted mean number of children ever born to women who had education up to primary level was 4.50 as against to 2.76 whose education was middle or above. The introduction of several demographic, socio-economic and cultural factors as controls makes little difference and the adjusted MCEB remained higher (4.12) among illiterates women than those educated up to primary (4.07) level or middle and over (3.90), though statistically not significance. Husband's education is expected to affect fertility differently from the way fertility is affected by the education of women because of their various roles and views in the wife's reproductive process. Husband's education also indicated an inverse association with the MCEB. The mean number of children ever born to women whose husbands were illiterate was 4.81 births (unadjusted) and 4.14 births (adjusted), Where as the unadjusted and adjusted MCEB to women whose husbands were educated up to primary, middle-higher and above inter were 4.61, 4.13, 3.64

births and 4.02, 3.17, 3.9 births respectively. Clearly, an increased level of education of husband was found associated with a decline in the number of children ever born.

3.3.2.2 Fertility in relation to occupation

Occupation is a measure of social status in the community as well as the economic circumstances of the family (Abdul Hakim, 1994). The MCA shows that women who belonged to households having domestic work as main occupation had comparatively lower fertility than those women who belonged to service category. The mean number of ever born children for women associated to households of domestic work was 3.8 as against to 4.6 for those belonging to service category. When it is adjusted differences were reduced and coincides about 4 ever born children. MCEB according to OCCHH indicated a high value (4.66 unadjusted and 4.28 adjusted) of MCEB among women who belonged to households whose OCCHH was service and low in women belonging to households whose OCCHH was agriculture. A high value MCEB in OCCHH group 'service' may be due to the fact that survey villages are not far away from the city of Varanasi. So they may be affected by the primary phase of modernisation, which cause higher fertility in early phase of this transition.

3.3.2.3 Fertility in relation to type of house and status of house

In unadjusted categories, the mean number of children ever born was slightly higher 4.63 birth in joint family set up than 3.56 births observed in Nuclear families. In the multivariate analysis, when adjusted, for other predictors, the difference in fertility became negligible and the value of MCEB in both types of families was closed to the value of 4 births.

The unadjusted mean number of children ever born was found slightly higher in those women who lived in Pakka house (4.25) followed by Kachcha (4.18)

and Mixed (3.88). In the multivariate analysis, when adjusted for other predictors, fertility remained higher among women belonging to Pakka house (4.17) followed by Mixed (4.11) and Kachcha (3.86).

3.3.2.4 Fertility in relation to economic and social status of household

A higher (4.47) mean number of children ever born was found among those women who belonged in low category of economic status than (4.21) in middle category and (3.58) in high category. When it was adjusted for other predictors, this pattern of fertility remained same and the MCEB was 4.26, 4.16 and 3.80 among women belonging to low, middle and high economic status group of the households.

However, Table 3.1 exhibited a reverse relationship between fertility and social status. The unadjusted mean number of children ever born was found higher among those women who belonged to low social status (4.44) than middle (4.22) and high (3.47) social status groups of the household. When controlled for other predictors, the pattern in fertility remained more or less same, where adjusted MCEB in low, middle and high social status groups were 4.14, 4.14 and 3.90 respectively.

3.3.3 Fertility and Cultural variables

3.3.3.1 Fertility in relation to caste and religion

A number of studies have shown low mean number of children for women belonging to upper castes than other. The main reasons pointed are the prevalence of education, higher socio-economic status, higher rate of mobility. All these factors indirectly inspired toward small family norm. The MCA provided consistent results to preceding studies where it was observed that women belonging to upper caste group had significant low MCEB (unadjusted 3.38 births and adjusted 3.85 births) than among women

belonging to scheduled castes (unadjusted 4.46 births and adjusted 4.41 births). The MCEB for other caste groups belonged between these two. Adjusted valued R-square (0.113) also revealed that the variable CASTE was the third most important contributory factor in explaining the distribution of MCEB.

The MCEB (unadjusted) in Hindu community was 3.9 a lower value than 5.3 found among Muslims. This pattern remained same when MCEB was adjusted for other demographic socio-economic variables.

3.4 Conclusions

The multiple R-Squared value indicated that the variation explained by all the independent variables was 59.9 per cent (Table 3.2). Among the predictors, the adjusted r-values indicated that age at marriage is the most significant variable followed by breastfeeding in describing the number of children ever born. Among the socio-economic variables economic status of the household, main occupation of the household, status of house, social status of the household, education of wife, education of husband and type of household are significant and subsequently important determinants of cumulative fertility. The cultural variables (caste and religion) were also found significant. However, a significant variate was noted on the individual effect of a predictor when adjusted after controlling for the effects of other predictors. This study, thus, reveals that to get a significant reduction in fertility, the status of women in terms of their education and occupation should be improved as well as old traditional social and cultural taboos and customs be modernised.

Table 3.1: MCEB according to Demographic, Socio-economic and Cultural Variables

Variables	Number	Unadjusted MCEB	Adjusted MCEB
Demographic variables			
Breast feeding (CBF) (in months)			
<12	309	3.602	4.073
12-23	354	3.983	4.184
24-35	241	4.481	3.949
36+	156	4.583	3.405
Age at Return Marriage (AGERM)(in years)			
<15	206	5.044	4.632
15-17	570	4.151	4.213
18+	284	3.215	3.388
Socio-economic variables			
Education of husband (EDUH)			
Illiterate	313	4.815	4.149
Primary	217	4.618	4.130
Mid-High	268	3.642	4.029
Inter+	262	3.179	3.982
Education of wife (EDUW)			
Illiterate	703	4.496	4.123
Primary	158	3.842	4.071
Middle+	199	2.764	3.900
Type of household (HHTYPE)			
Joint	502	4.637	4.100
Nuclear	558	3.566	4.050
Main occupation of the household (OCCHH)			
Agriculture	122	3.705	3.785
Service	334	4.656	4.278
Domestic	604	3.826	4.018
Status of house (HOUSE)			
Kachcha	242	4.186	3.860
Pukka	338	4.257	4.172
Mixed	480	3.887	4.112

Table 3.1 (continued)

Variables	Number	Unadjusted MCEB	Adjusted MCEB
Economic status of the household (ECONHH)			
Low	270	4.478	4.262
Middle	442	4.210	4.166
High	348	3.586	3.809
Social status of the household (SOCIALHH)			
Low	318	4.443	4.143
Middle	433	4.226	4.141
High	309	3.479	3.907
Cultural variables			
Religion (RELIGN)			
Hindu	952	3.916	4.008
Muslim	108	5.407	4.457
Caste (CASTE)			
Upper	221	3.376	3.846
Middle	389	3.967	3.944
Business	155	3.948	4.044
Schedule	187	4.455	4.414
Muslims	108	5.407	4.457

Table 3.2: MCA ANALYSIS

Model	Unadjusted (r)	Adjusted (r)
CBF	0.1628	0.1889
AGERM	0.2659	0.2608
EDUH	0.2934	0.0346
EDUW	0.2874	0.0412
HHTYPE	0.2296	0.0141
OCCHH	0.1703	0.0927
HOUSE	0.0735	0.0693
ECONHH	0.1533	0.1049
SOCIAL	0.1682	0.0500
RELIGN	0.1942	0.0387
CASTE	0.2408	0.1131
R (Overall)		0.7740

Model	Unadjusted (r^2)	Adjusted (r^2)
CBF	0.0265	0.0357
AGERM	0.0707	0.0680
EDUH	0.0861	0.0012
EDUW	0.0826	0.0017
HHTYPE	0.0527	0.0002
OCCHH	0.0290	0.0086
HOUSE	0.0054	0.0048
ECONHH	0.0235	0.0110
SOCIAL	0.0283	0.0025
RELIGN	0.0377	0.0015
CASTE	0.0580	0.0128
R (Overall)		0.5990

CHAPTER - IV

CHAPTER-IV

BREASTFEEDING: A HAZARD MODEL ANALYSIS

4.1 Introduction

Studies on breastfeeding have been a subject of great concern in both developed and developing countries because of its important implication, not only for improving the health condition of children, but also for lowering fertility. Besides, biological factors, human fertility behaviour depend on a number of socio—economic, demographic, psychological, and cultural factors. Breastfeeding is one of these which affects fertility by prolonging the duration of post partum amenorrhoea and hence, length of related birth interval. In a society where prevalence rates of modern contraception are low, duration of breastfeeding is considered to be an important determinant of intervals between births in developing countries (Kleiman and Senanayake 1984). However, the amount of effect of breastfeeding depends on its parameters, viz.: duration, frequency and intensity, prevalent in the society.

It has been argued that the suckling stimulus of breastfeeding is one of the main cause of its effect in the reduction of fertility, and the frequency, intensity and timing of suckling all determine the extent of this effect (Guz and Hobcraft 1991). It has been reported that the length of ovulation depends on the duration of breastfeeding, especially the intensity and frequency of suckling (Brown *et al.*, 1985), and also depends on both the return of menstruation and resumption of normal sexual relations (Hall and Simpson 1985; Santow 1987).

Usually, impact of breastfeeding on fertility has been related with the duration of Post partum amenorrhoea (PPA). Habicht *et al.* (1985) have mentioned that breastfeeding beyond the resumption of menstruation can not affect the duration of PPA and an estimated effect of breastfeeding on

fertility may be biased. Whereas McNeilly *et al.* (1985) have argued that continued breastfeeding may further delay resumption of ovulation and interfere with the frequency of menstrual cycles.

Some of the factors associated with differentials in breastfeeding have been region, place of residence - rural/urban, education, social status, mother's age, parity, use of contraception, employment status, etc. Based on WFS data, a higher duration of the breastfeeding has been found in African and Asian countries than in Latin American and the Caribbean (McCann *et al.*, 1984). The duration of breastfeeding has been found shorter in urban areas than in rural areas, particularly in developing countries (Huffman 1984). Jain and Bongaarts (1981) reported an inverse association of mother education with the duration of breastfeeding after controlling other socio-economic and demographic factors. Several others, for example, Mott (1984) in Kenya, Knodel *et al.* (1982) in Thailand, Bracher and Santow (1982) in Central Java, Guidkey *et al.* (1990) in Philippines and Gaisie (1981) in Ghana, have reported a similar finding. Trussell *et al.* (1992), in analysing the data of WFS and DHS of several countries, have also documented a longer duration of breastfeeding among rural women, and nearly an universal tendency for the duration to decline with increased education. Studies conducted in Sri Lanka and east countries like Jordan, Tunisia, Yemen, and Egypt have, however, reported some mixed results regarding the effect of female education on the duration of breastfeeding. An overtime declining pattern in the mean duration of breastfeeding has also been found, but reaching to a point of near universal (Chayovan *et al.*, 1990; Popkin *et al.*, 1991; Anh *et al.*, 1995).

As said in chapter I, prolonged breastfeeding has been a traditional feature of infant and child nutrition, especially in African and Asian countries (Huffman 1984; Ofosu 1989). Extended and demand breastfeeding is prevalent in India, night breastfeeding is common as the child sleeps with the mother. The longer and more frequent breastfeeding is, perhaps, used to ensure the survival of the child (Caldwell and Caldwell 1977; Gaisie 1984).

However, differentials and determinants of the duration of breastfeeding discussed in numerous studies are not straightforward. Studies conducted in different parts of the world, at different points of time, are not comparable as they vary in questions asked, birth order taken, and methodology of analysis used (Trussell *et al.*, 1992). Further, in all the previous studies, either the 'retrospective' reporting or the 'current status' reporting of the breastfeeding (BF) has been used. In the present chapter some known differentials of the mean duration of BF with some explanatory variables have been confirmed as well as some new differentials have been investigated. Both univariate and multivariate statistical techniques are used. Both 'retrospective' and 'current status' reportings of breastfeeding have been utilised for studying the levels and differentials in the duration of BF. The retrospective reporting refer to asking the mother about the duration of BF subsequent to the birth of her *last but one* child, whereas the current status reporting entail noting mother's BF following the birth of her *last* child at the survey date.

4.2 Data and Methodology

The data for this chapter are taken from the sample survey entitled " Effect of Breastfeeding on Fertility in Northern India- A Sample Survey - 1995". The details about survey and information collected their in are given in section 3.2 of chapter III. However, in brief, the dependent and independent variables along with their measurements are given below:

As mentioned in chapter III, a separate section in the schedule was devoted to seeking additional information on births, particularly the *last* and the *last but one* birth that occurred to couples in the households during the seven years preceding the survey date (March 1995). Married women aged under 50 years and living with their husbands at the survey date provided the fertility, breastfeeding, post partum amenorrhoea, birth intervals, and family planning information.

The survey collected information from 1022 households, 1060 mothers about their *last* birth, and 767 mothers about their *last but one* birth. Information on the duration of breastfeeding following the *last* birth and the *last but one* birth was collected by asking direct questions to mothers: 'How many months was a child on the mother's breast milk only? How many months a child breast fed along with supplementary food?'. Some mothers did not start weaning by the survey date and their experience was, therefore, censored.

4.2.1 The dependent and independent variables

Data on the duration of full breastfeeding (FBF), partial breastfeeding (PBF) and combined breastfeeding (CBF) are available for this sample, but due to a high collinearity between them, differentials in the mean duration of the CBF have been studied. However, some idea about the pattern of the duration of the FBF has also been given. Thus, the duration of breastfeeding in completed months is used as the dependent variable. The independent variables, all measured at the survey date, are classified as follows:

4.2.1.1 Demographic variables

The variables included are: post partum amenorrhoea (PPA), first birth interval (FBI), last closed birth interval (CLOSE), open birth interval (OPEN), age of mother (AGEMOTH), age of mother at the birth of the child (AGEMOTC), age at return marriage (AGERM), parity of mother (PARITY), age of child (AGECH), survival status of child (CHALIVE), and sex of child (SEX).

The PPA is the period following the termination of a pregnancy during which conception does not occur. It is measured in completed months. The censored cases of the independent duration variable PPA have been allocated a duration equivalent to OPEN. OPEN is the interval between the *last* birth and the survey date. CLOSE is defined as the time period between

the penultimate child and the most recent child. FBI is the time period between the date of marriage and date of the first birth. All birth interval variables are measured in completed months.

AGEMOTH, AGEMOTC and AGERM were all measured in completed years. The AGERM is the age at which a couple starts living together for consummation after a ceremony known as *Gauna*, that may be performed after several years of marriage. The AGECH is measured in completed months. CHALIVE is classified as alive if the *last but one* child or the *last child* was alive at the time of occurrence of the next event (*i.e.* at birth of the next child or at the survey date respectively), and dead if the child was dead before the occurrence of the next event.

4.2.1.2 Socio-economic variables

The variables included are: type of household (HHTYPE), status of house (HOUSE), main occupation of the household (OCCHH), economic status of the household (ECONHH), social status of the household (SOCIALHH), education of wife (EDUW), and education of husband (EDUH) (Measurements of all these variables are given in section 3.2 of chapter III).

4.2.1.3 Cultural variables

Two variables included are religion (RELIGION) and caste (CASTE). Religion is split into two categories as Hindus and Muslims. For measurement of these two variables see section 3.2 of chapter III.

4.2.2 Distribution of the BF

Figure 4.1 shows the distribution of the duration of breastfeeding among mothers of the *last* child and the *last but one* child. Both child cohorts indicate heaping in the breastfeeding duration at the multiple of 6 months. A

similar pattern of heaping in the breastfeeding duration has also been reported in studies conducted in India (Sriniwasan *et al.*, 1989; Singh 1993), Bangladesh (Nessa, *et al.*, 1987; Rahman 1992; Mannan and Islam 1995), Indonesia (Jones 1989), Africa (Ofosu 1989; Amenuvegbe 1994) and many other developed and developing countries (Thapa and Williamson 1990; Trussell *et al.*, 1992). The reasons for the heaping in the duration of the breastfeeding data reported by these studies are mis-reporting, culturally prescribed norms, memory lapse and selection bias. No adjustment for heaping of the breastfeeding data was made in the present study. However, multimodal distributions could, in fact, be obtained even though all respondents report their breastfeeding durations accurately because each subgroup in the population has a different unimodal distribution. Nevertheless, it is difficult to detect the systematic tendencies of under reporting and over reporting in the breastfeeding duration unless the errors are gross. Over reporting in the breastfeeding data may lead to some visible inconsistencies, like breastfeeding duration in excess of the current age of the child or its age at death, whereas under reporting would not result in any visible inconsistencies and therefore remain unnoticed (Amenuvegbe 1994).

As mentioned earlier usually, two approaches - 'current-status' and `retrospective' - have been used in analysis of the breastfeeding data. Both types of data have their merits and demerits. The current-status data suffered from less response error since no or less recall is involved. Further, studies have advocated that life table approach is more appropriate for the analysis of casual data in the presence of censoring, usually found in current-status data (Leon and Potter 1989). Life table approach also provides some more detailed information on the duration of breastfeeding in the current-status as it takes advantage of additional information than on retrospectively reported ages at which events occur (Anh *et al.,* 1995). The life table technique also ensures that the estimated proportions currently breastfeeding decline monotonically with successive months since birth. Univariate and multivariate statistical techniques have been used to study

the predictor variable, the breastfeeding duration in relation to the explanatory variables given in the following section. For bivariate analysis of the breastfeeding, the duration of BF is grouped in 6 monthly intervals. All other variables are grouped as shown in Appendix Table 4.A. Assuming that breastfeeding started soon after the birth, the censored cases of the duration dependent variable (BF) have been allocated a duration which is the same as the age of the child at the survey date. The mean duration of the BF is computed from ungrouped data after making it a continuous variable (by adding 0.5 to each reported duration in completed months).

The association of the duration of the BF with all the variables included in this study is first checked by the Chi-square statistic in a two-way tabulation of each variable (Table 4.2). Chi-square statistic has also been used to test the goodness of fit of the model as well as to test the significance of the explanatory variables.

The Survival analysis (Life table) is used to examine the duration probabilities of the weaning according to the characteristics of the mothers and children. The survival analysis calculates the probability distribution of mothers who continue to be in the breastfeeding state at specific BF durations since the birth of the child. Various summary measures based on this distribution are also calculated (see Appendix Table 4.A).

The univariate proportional hazard model analysis is used to give a measure of the effect of each variable on the duration-specific probabilities of the weaning (hazard function) in the absence of the control for other variables (Table 4.3). A multivariate proportional hazard model analysis is then undertaken to provide a measure of the effect of each category of each variable on the hazard function while controlling for the effects of other variables (and their categories) included in the model (Table 4.4).

Analysis is carried out separately for the BF distribution following the birth of the *last* and the *last but one* child. Some explanatory variables, which were inter-related, were excluded from the multivariate hazard modelling.

4.3 Results and Discussion

4.3.1 Pattern of the FBF

Though the present paper is concerned with a detailed analysis of the duration of the CBF, henceforth be called as BF, a brief outlook of the distribution of FBF prevailed in the community has also been given in this section. Figure 4.2 shows the percentage distribution of the duration of FBF in both current-status and retrospective data. Both data sets indicated a similar pattern of distribution with heaping at the multiple of 6 months. There were about 7 per cent censored cases in the *last* child data. Surprisingly, there were about 3 per cent censored cases in the *last but one* child cohort too. It may be mainly due to the fact that in the case of infant death or still birth, mothers continue to breast feed their previous child. Even if the child is alive but weak and sick, mothers used to breast feed along with the current child. An equal mean duration of the FBF of about 5 months was found among mothers of the both child cohorts.

The two survival curves of the distribution of the FBF differed from one another significantly (Figure 4.3). More than half of the children (about 61% in each child cohort) were weaned during their 6th month of life. Even about 4% mothers (3.3% in respect of the last child, and 5.2% in respect of the *last but one* child) continued to put their child on full breastfeeding at 18 months (Appendix Table 4.B).

Some socio-economic, demographic, and cultural correlates of FBF are presented in Table 4.1. A multivariate hazard model analysis indicates that the variables post partum amenorrhoea (PPA), status of house (HOUSE),

education of wife (EDUW) and husband (EDUH), and survival status of child (CHALIVE) have significant influence on the duration of the FBF. The variable AGECH has also been found to relate to the FBF in respect of the last child. FBF was positively related with the PPA, and inversely with EDUW and EDUH. An educated mother fully breast fed for a shorter period than illiterates. The duration of the FBF was also found shorter for mothers living in Pukka houses than those living in Kaccha houses.

4.3.2 Pattern of the BF

The ordinary mean, medians, and range for the duration of the BF were 20.5, 18.5, 72 months (in case of the *last* child) and 20.8, 18.5, 72 months (in case of the *last but one* child) respectively. However, survival analysis, when censoring of the duration of the breast feeding is taken into account, revealed a higher mean duration of the BF (about 25 months) for mothers in respect of the *last* child than (about 19 months) for mothers in respect of the *last but one* child (Appendix Table 4.A). This may be due to a high per cent of censored cases (about 46%) in the last child cohort. The censored cases averaged a mean duration of the BF of 16.4 months in case of the *last* child and 46.2 months, though small in number, in case of the *last but one* child, and hence it turned into a higher mean duration of the BF in data of the *last* child cohort. This happened because of the fact that survival analysis provides, theoretically, a higher value of probabilities at the later categories of breastfeeding duration due to censoring (Trussell *et al.*, 1992).

The two survival curves of the distribution of the breastfeeding differed significantly from one another (Figure 4.4). A universal pattern in the BF data was found as there were only 1.2% mothers in the *last* child and 1.6% in the *last but one* child cohort whose duration of the BF was less than 6 months. About 32% and 10% mothers respectively in the *last* and the *last but one* child cohort continued breastfeeding even after 36 months which shows a pattern of prolonged breastfeeding in the region under study. The median

duration of the BF distribution was 26.3 and 18.5 months respectively in *last* and the *last but one* child cohort.

As compared to some Indian studies, this study reported a slightly shorter mean duration of the BF. Singh (1993), for example, reported, based on a sample data of *last but one* child, a mean duration of breastfeeding of 19.6 months in rural area, and 17.9 months in urban area of eastern Uttar Pradesh, whereas Prema *et al.* (1981) reported, based on a sample data of South India, a median duration of breastfeeding of 20.7 months. Sriniwasan *et al.* (1989), based on the data of the *last* child in Orissa, showed a median duration of 28.6 months in rural area and 23.8 months in urban area. Some other studies in developing countries reported a median duration of breastfeeding which varies from 14 to 24 months (in last closed birth interval), from 18 to 31 months (in open birth interval) in West African countries Cameroon, Benin, and Ghana (Ofosu 1989; Amenuvegbe 1994), from 22 to 32 months in Bangladesh (Huffman *et al.*, 1987; Hague *et al.,* 1989; Salway *et al.*, 1993; Mannan and Islam 1995) and around 17 months in Vietnam (Anh *et al.*, 1995). A high value of censoring of about 41 and 55 per cent in the BF data has also been reported in West African countries Cameroon and Benin (Ofosu 1989). Thus, this study showed an almost universal pattern of breastfeeding in rural Northern India, but a tendency to decline in the duration over time.

4.3.2.1 Breastfeeding and Demographic Variables

4.3.2.1.1 BF in relation to FBF

The pattern of the duration of BF across the distribution of the duration of FBF shows that the duration of the FBF accelerated the duration of BF, and both variables have a positive and significant relationship in respect of both the *last* and the *last but one* child (Table 4.2). The mothers who had experience of 0-2 months of the duration of FBF terminated the BF at 12

months in about 15 and 25 per cent cases in *last* and *last but one* child cohort respectively, whereas the termination of the BF was only in about 0.0 and 14 per cent of mothers in *last* and the *last but one* child who had experience of 9 or more months of the FBF. Similarly, the mean duration of BF for mothers who had the FBF of 0-2 months, was 21.9 months in the *last* and 16.8 months in the *last but one* child cohort. Whereas, for mothers who had experience of more than or equal to 9 months of the FBF, the mean duration of the BF was 30.7 and 26.2 months respectively in the last and the last but one child data set. Figure 4.5 also shows an increased trend in the duration of BF by the duration of FBF.

Univariate proportional hazard model analysis also depicted a highly significant relationship where the variable FBF has an impact on the hazard function of the BF (Table 4.3).

4.3.2.1.2 BF in relation to Post Partum Amenorrhoea

During the last more than three decades data are being collected on the durations of breastfeeding and post partum amenorrhoea, and a positive relationship between the two has been developed (Potter *et al.,* 1965; Perez *et al.*, 1971; Jain and Bongaarts 1981; Habicht *et al.*, 1985; Guz and Hobcraft 1991). A simple two way tabulation revealed a relationship of the PPA with the distribution of the duration of the BF (Table 4.2). The duration of BF across the different PPA groups exhibited a positive, but a J-shaped relationship (Figure 4.5). This shows that there are two types of mothers in the society, one who even with a shorter duration of the PPA breast fed for a longer duration.

Survival analysis shows that about 2 and 3 per cent mothers in *last* and *last but one* child cohort respectively, terminated BF during first 6 months who had experience of 0-2 months of the PPA, whereas only about 1 per cent mothers did so in each child cohort who were amenorrhoeic for 9+ months.

The mean duration of the BF across the different PPA groups increased from a low value of 22.9 months in respect of the *last* child and 16.9 months in respect of the *last but one* child, for mothers who were amenorrhoeic for 3-5 months, to a high value of 26.3 and 21.9 months for those mothers who had experience of more than or equal to 9 months of PPA in respective child cohort.

Univariate proportional hazard analysis also showed a significant impact of the PPA on the hazard function of the BF in respect of the *last but one* child (Table 4.3). This pattern was maintained in the multivariate proportional hazard model analysis. An insignificant effect in respect of the *last* child may be due to a high per cent of censoring. Thus, this study confirms a relationship between the duration of breastfeeding and the duration of post partum amenorrhoea.

4.3.2.1.3 BF in relation to Birth Intervals

Though the role of breastfeeding in describing the pattern of length of birth interval has been discussed and a positive relationship has been found between the two (Ofosu 1989; Trussell *et al.,* 1992; Singh 1993; Amenuvegbe 1994; Mannan and Islam 1995), studies dealing with the reverse pattern are scant. In this section, differentials in the mean duration of the BF have been studied across the duration of the last closed birth interval (CLOSE), open birth interval (OPEN), and first birth interval (FBI). The distribution of the duration of BF was found significantly related with the CLOSE in respect of the last but one child, and with the OPEN in respect of the last child (Table 4.2). Surprisingly, the duration of the BF has also been found related with FBI in the last child data. The mean duration of BF was found lengthened by the increase in the length of CLOSE. The mean duration of the BF in CLOSE groups 0-23, 24-35, 36-47, and 48+ were found to be 14.6, 19.3, 23.5, and 23.7 months respectively. About 70% of mothers terminated breastfeeding who had a CLOSE of 0-23 months, much higher

than about 26% who terminated the BF in the CLOSE of 36-47 months. This study, however, showed that the closed birth interval after a certain length of duration has little or no impact on the duration of the BF. For example, the CLOSE after 36 months has no significant effect on the BF (see Figure 4.5).

Univariate proportional hazard model analysis exhibited a high relationship between CLOSE and the duration of the BF (Table 4.3). Even after controlling the effects for other explanatory variables (multivariate hazard analysis), a significant relationship exit between the two (Table 4.4). This implies a strong relationship between the length of the last closed birth interval and its related duration of breastfeeding.

The mean duration of the BF was extended by the increase in the length of OPEN. It is a minimum of 18.8 months in OPEN 0-11 months and a maximum of 25.5 months in OPEN 24-35 months. Like CLOSE, the duration of the BF was not very much affected by OPEN after 36 months (see Figure 4.5). Though the univariate hazard model exhibited no significant relationship between the two, multivariate hazard analysis shows that the risk ratio for mothers whose OPEN was over 36 months was significant than for those whose OPEN was less than 36 months (Table 4.4). However, due to high per cent of censored cases it is difficult to conclude on the effect of OPEN on the duration of breastfeeding.

Though means and trimeans of the BF increased by the increase in FBI, univariate and multivariate hazard analyses did not show any significant relationship between the two.

4.3.2.1.4 BF in relation to Parity and Age Variables

A variable related to age is, usually, used to control for cohort (to see variation over time) and/or looking for variation in fecundability (*e.g.* older females may breast fed for a longer duration due to less chance of becoming

pregnant) (Trussell *et al.*, 1992). Several authors reported a higher duration of the BF with age of mother and birth order of child (Huffman *et al.,* 1980; Ferry and Smith 1983; Ahamed 1986; Mannan and Islam 1995), while some others found no significant association of the BF with these variables (Sriniwasan *et al.*, 1989; Ofosu 1989; Amenuvegbe 1994).

Last child cohort's breastfeeding differentials averaged a low value of 22.2 months among mothers of age 16-24 years, to a maximum of 25.7 months for mothers aged 35 and above. The *last but one* child data revealed a similar pattern. The hazard of terminating the BF among mothers of both the child data sets appeared similar across the AGEMOTH. Both univariate and multivariate hazard model analyses, however, exhibited insignificant relationship between the variable AGEMOTH and the duration of the BF, except in the last child data set where mothers aged 24-34 years showed a significantly different and longer duration of the BF than mothers aged 16-24 years (Table 4.4).

Mother's age at the birth of the child (AGEMOTC) shows a similar pattern of differentials in the BF as found according to AGEMOTH in both sets of data. Though a simple two way tabulation shows a significant association between the BF duration and the AGEMOTC for mothers in the *last* child (Table 4.1), the hazard model analyses did not reveal any significant association between these two (Tables 4.3 and 4.4).

PARITY demonstrates a similar pattern of association with the duration of the BF as found with AGEMOTC. It was found related to the distribution of the BF only in respect of the *last* child (Table 4.1). The mean duration of BF was increased by the increase in the PARITY. For example, mothers with parity 1-2 breast fed for an average of about 24 months in the last child cohort, and 19 months in the last but one child cohort, which rises linearly to about 27 months and 20 months respectively, in the *last* and the *last but one* child cohorts who were of parity 7 and above. However, the effect of PARITY

in explaining the duration of the BF, estimated through proportional hazard model analyses, was found insignificant in both child cohorts.

The differential in the duration of BF by age at return marriage (AGERM) shows an inverse relationship. Mothers breast fed on the average 27.3 months in respect of the *last* child, and 20.6 months in respect of the *last but one* child whose AGERM was 9-14 years, while those who married at aged 18 and above breast fed for a shorter period of 23 months and 18.6 months in *last* and *last but one* child cohort respectively. However, like other age variables, AGERM has a significant relation with the distribution of the duration of the BF in respect of the *last* child (Table 4.2), its estimated effects, based on hazard model analyses, were not significant in both data sets.

4.3.2.1.5 BF in relation to Sex, Age and Survival Status of the Child

As expected, a significant association between the duration of BF and survival status of a child (CHALIVE) was found in data sets. Mothers stop breastfeeding just after the death of the child, which, obviously results in a shorter breastfeeding duration in this case. Mothers, whose child was alive until the occurrence of the next event (birth or survey date), breast fed on average for a longer duration (25.1 months in case of the *last* child and 19.2 months in case of the *last but one* child) than those whose child was found dead (21.4 and 16.6 months in case of *last* child and the *last but one* child respectively). Both univariate and multivariate hazard model analyses also revealed a highly significant association between these two (Tables 4.3 and 4.4). Both child cohorts showed no evidence of marked differentials in the duration of BF by SEX of the child.

As may be expected, the present age of child (AGECH) has a positive relationship with the breastfeeding duration in both the data sets. However, due to a high per cent of censored cases in the *last* child cohort, and small

number of observation in some cells of the *last but one* child, it is not worth studying the relationship of the variable AGECH with the duration of the BF.

4.3.2.2 Breastfeeding and Socio-economic Variables

4.3.2.2.1 BF in relation to Education

Socio-economic status of women is found highly relative to the duration of breastfeeding in developing countries. Education is one of the important factors of measuring socio-economic status of a society. Due to low level of literacy among females in India, education of the husband has been considered by some of the researchers as a proxy of the socio-economic status to study the differentials in the breastfeeding duration (*e.g.* Singh 1993). The effect of education on the duration of BF has shown mixed evidences. In many developing countries (Bangladesh, Colombia, India, Indonesia, Jordan, Panama and Sri Lanka), breastfeeding duration is found inversely related with education, *i.e.* risk of early weaning increases with education (Huffman *et al.*, 1980; Jain and Bongaarts 1981; Ahamed 1986; Sriniwasan *et al.*, 1989, Singh 1993; Anh *et al.*, 1995), whereas in many developed countries, educated females breast fed for a longer duration (Trussell *et al.*, 1992). The husband's education has also been found related with the duration of breastfeeding (Akin *et al.*, 1986; Singh 1993). Mott (1984) has, however, found that once the effect of the wife's education and residential status are taken into account, the effect of the husband's education and occupation is reduced or eliminated.

Education of mothers (EDUW) was found related with the BF in both the data sets (Table 4.2). The mean duration of the BF increased by the decrease in the educational level of the mothers (Figure 4.5).

For example, illiterate mothers breast fed on the average 26.1 months in respect of the *last* child, and 19.7 months in respect of the *last but one* child,

which linearly decreased to 22 months in the *last* and 18.5 months in the *last but one* child cohort respectively, for mothers educated more than or equal to middle standard. Survival analysis shows that the percentage of the illiterate mothers who terminated breastfeeding at 36 months was lower (62.3% in the *last* child and 88.8% in the *last but one* child) than those who were highly educated (middle+) (87.2% in the *last* child and 95.1% in the *last but one* child). Univariate proportional hazard model analysis exhibited a significant contribution of EDUW in explaining the duration of the BF in both child cohorts (Table 4.3), more so in last child cohort. The multivariate hazard model analysis shows that the risk ratio for mothers whose education was middle and above was more significant than for those who were illiterates in respect of the *last* child. However, the difference in the duration of breastfeeding pattern between illiterate mothers and primary level educated mothers was not found to be significant in both data sets (Table 4.4).

The husband's education (EDUH) has also been found related to the duration of the BF (Table 4.2). The mean duration of BF decreased with the increase in the level of the husband's education (Figure 4.5). The mean duration of the BF was found to have decreased from 25.4 and 20.4 months in *last* child and *in last but one* child cohort, for mothers having illiterate husbands, to 23.6 and 18.3 months in respective child cohort, for mothers having husbands with higher education, Inter+ (12 class or more). The univariate proportional hazard model analysis revealed that EDUH has an impact on the hazard function of the BF (Table 4.3). However, after controlling the effects of the other explanatory variables, the variable EDUH has its significant impact on the duration of BF except in the last child data, where mothers of illiterate husbands had significantly a different BF than mothers having husbands with education at the primary level (Table 4.4).

4.3.2.2.2 BF in relation to Household Level Variables

Mothers living in joint households averaged slightly higher duration of the BF than for those living in nuclear households in respect of the both child cohorts. Similarly, mothers belonging to the OCCHH group agriculture averaged slightly less duration of the BF than for mothers of other occupations. However, variables HHTYPE and OCCHH were found to significantly relate with the distribution of the duration of the BF. Univariate and multivariate hazard analyses had revealed not a significant effect of HHTYPE and OCCHH on the duration of the BF, except in respect of the last but one child where univariate hazard model provided some impact of the HHTYPE on the hazard function of the BF (Tables 4.3 and 4.4).

Status of house (HOUSE) appears to have some mixed evidence regarding its association with the duration of the BF. It was related with the distribution of the duration of BF in respect of the *last but one* child but not with the *last* child (Table 4.2). Mothers living in the Kaccha houses breast fed on average a longer period than those belonged to Pukka or Mixed houses. Though, univariate hazard model analysis revealed a significant impact of this variable on the duration of BF in both data sets (Table 4.3), multivariate hazard analysis revealed no differentials in the duration of the BF across the status of house (Table 4.4).

The variables ECONHH and SOCIALHH exhibited some zigzag pattern of relationship with the distribution of BF. ECONHH was found related with the BF in respect of the *last* child, whereas SOCIALHH was found related with the BF in respect of the *last but one* child (Table 4.2). It was found that mothers of low ECONHH and low SOCIALHH breast feed on the average a higher duration than other mothers (Appendix Table 4.A). The duration of BF was found increased by the increase in the social and economic status of the household. The univariate hazard model analysis also revealed that both the variables have an impact on the hazard function of the BF (Table 4.3).

However, their estimated contribution, after controlling the effects of the other explanatory variables, in explaining the duration of BF was not significant in both data sets (Table 4.4). The household level variables, thus, have no significant influence on the duration of breastfeeding.

4.3.2.3 BF in relation to Cultural Variables

Two variables CASTE and RELIGION are discussed in this section. The variation in the duration of the BF according to CASTE and RELIGION has been observed in many developing countries like India (Sriniwasan *et al.*, 1989), Bangladesh (Mannan and Islam 1995), and Ghana (Amenuvegbe 1994). The variable CASTE was found related with the distribution of the BF in both the data sets, whereas the variable RELIGION was related only in data of the *last* child (Table 4.2). Differentials in the duration of BF by CASTE show that High caste's mothers breast feed on average for a shorter duration (23 months in the *last* child cohort and 18.4 months in the *last but one* child cohort) compared to other castes. Scheduled castes mothers were found to breast fed for a longer duration. The univariate hazard model analysis revealed a significant impact of the variable CASTE on the BF (Table 4.3). However, after controlling the effects of the other explanatory variables, its effect disappeared. The variable RELIGION exhibited that the Hindus females breast feed on the average a slightly longer duration than Muslims. Both univariate and multivariate hazard models, however, did not find any significant association between the two variables RELIGION and BF.

4.3.3 Retrospective and Current Status BF data

As mentioned in previous sections, the level (mean, median or trimean) of the duration of the BF and its demographic, and socio-economic correlates were calculated from both the `retrospective' and `current status' data. It was noted that while the differentials in the duration of the BF by characteristics

of women or child, were identical in these two types of the BF data, the level of the duration of the BF was quite different. The mean duration of the BF was 20.5 months in respect of the *last child* (current status data) and 20.8 months for the *last but one* child (retrospective data). Further, the mean duration of the BF subsequent to the birth of the *last but one* and the *last child* of the same mother (725 mothers), who reported a median duration of the BF of 19.3 months following the birth of the *last but one* child, and 20.8 months following the birth of the *last child* also revealed a statistical difference between the risk ratios for the *last* and the *last but one* child of these mothers. The survival analysis technique, which took into account the censoring of the cases revealed a higher median (26.3 months) and trimean (26.8 months) of the duration of the BF for the *last child* than for the *last but one* child (median 19.4 and trimean 18.8 months). Inclusion of a variable BLAST, indicating whether the child was the *last* or the *last but one*, in the proportional hazard model analysis revealed significant difference between the risk ratios for the *last* and the *last but one* child (not shown in this paper), which confirmed that even after the control for the demographic and socio-economic covariates, the BF distributions for the birth of the *last* and the *last but one* child were different.

The 'current status' data had better coverage but had censored cases, whereas the `retrospective' had missed information for some mothers. For example, there were 199 women who had given birth to two or more children but not reported the duration of the BF for the *last but one* child in this survey. In both types of data, the reporting of the duration of the BF might be influenced by not remembering it correctly. The recall lapses may be higher for births that occurred a long time ago *i.e.* in 'retrospective' reporting. On balance, it appears that the 'current status' data are better for providing estimates of the median duration of the BF than the `retrospective' data.

4.4 Conclusions

The study showed nearly an universality in the pattern of breastfeeding in Eastern Uttar Pradesh, but a slightly lower mean duration of breastfeeding than the preceding Indian studies. Both data sets exhibited a pattern of heaping in the distribution of the duration of breastfeeding at the multiple 6 months. Nearly mothers terminated their BF during the first 3 months following the birth of the *last* as well as the *last but one* child. In case of the *last* child, per cent of the mothers had not terminated their BF by the survey date. These cases were censored.

Old age mothers of the higher parity breast fed for a longer duration than others, but not a difference of significant level.

Both the wife's and husband's education was inversely associated with the duration of breast feeding. Illiterate mothers, or those husbands were illiterate, breast fed for a longer duration than others. However, after controlling for the effects of the other explanatory variables, the influence of the husband's education becomes statistically insignificant.

Mothers living in joint and Kaccha households, or in households having low social and economic status, averaged a longer duration of breastfeeding than those living in other types of households. However, the household level variables were not significantly related with the duration of breastfeeding.

Survival status of the child had a significant impact on the duration of breastfeeding. The sex of the child showed no differentials in breastfeeding duration. High caste's mothers breast fed for a shorter duration than other castes. Statistically not significant, but Hindus mothers breast fed for a longer duration than Muslims.

Overall, the findings of this study demonstrate that mothers living in upper strata breast fed for a shorter duration than their counterpart.This study provided an opportunity to examine the duration of the BF in respect of the *last but one* child (*i.e.* 'retrospective' data) and the *last* child (*i.e.* 'current status' data) which had % censoring. There is debate in the literature as to which of these two types of data give better estimate of the mean duration of BF. As noted, the mean duration of BF was longer in the case of the 'current status' data (*i.e.* BF following the birth of the *last* child) than 'retrospective' data (i.e. BF following the birth of the *last but one* child).The 'retrospective' data missed information on some mothers who provided information about their *last child* in the 'current status' data. Additionally, if there was a change in the duration of the BF with time, the 'current status' data would catch that change, whereas the 'retrospective' data would miss it (Trussell *et al.*, 1992). The reporting bias may occur in both types of data sets, but probably these may be higher in the 'retrospective' data due to the longer recall period. Thus, on balance it appears that the 'current status' data provide a better source than the 'retrospective' data for the analysis of the duration of BF.

Table 4.1: Hazard Model Analysis - Full Breastfeeding

		LAST CHILD		LAST BUT ONE CHILD	
VARIABLE	GROUP	Risk Ratio	p	Risk Ratio	p
FBI	0-17	.	.	.	.
	18-29	1.086	0.3996	1.107	0.3874
	30-41	1.046	0.6582	1.100	0.4421
	42+	0.967	0.7533	1.013	0.9226
PPA	0-2	.	.	.	.
	3-5	0.863	0.1984	0.992	0.9540
	6-8	0.804	0.0539	0.798	0.0750
	9+	0.845	0.0306	0.781	0.0098
OPEN	0-11	.	.		
	12-23	1.352	0.1607		
	24-35	1.119	0.6652		
	36+	1.238	0.3913		
CLOSE	0-23			.	.
	24-35			0.965	0.7215
	36-47			0.954	0.7083
	48+			0.821	0.1667
PARITY	1-2	.	.	.	.
	3-4	0.893	0.2655	1.111	0.3445
	5-6	0.864	0.2582	0.891	0.4780
	7+	0.934	0.6615	0.902	0.5993
AGEMOT	16-24	.	.	.	.
	25-34	1.131	0.3141	0.945	0.6568
	35+	1.017	0.9249	0.799	0.2083
AGEMOC	10-24	.	.	.	.
	25-34	1.056	0.6228	1.184	0.1544
	35+	1.102	0.5699	1.301	0.2418
AGERM	9-14	.	.	.	.
	15-17	0.942	0.5122	0.837	0.1014
	18+	0.989	0.9225	0.802	0.1177
EDUH	ILLITERATE	.	.	.	.
	PRIMARY	1.237	0.0295	1.206	0.0882
	MID-HIGH	0.984	0.8747	1.147	0.2271
	INTER+	1.109	0.3879	1.187	0.2482
EDUW	ILLITERATE	.	.	.	.
	PRIMARY	1.232	0.0430	1.081	0.5280
	MIDDLE+	1.200	0.1163	0.954	0.7546
RELIGION	HINDU	.	.	.	.
	MUSLIM	0.654	0.2903	1.040	0.9236

Table 4.1 (Continued)

VARIABLE	GROUP	LAST CHILD Risk Ratio	LAST CHILD p	LAST BUT ONE CHILD Risk Ratio	LAST BUT ONE CHILD p
CASTE	HIGH	.	.	.	.
	MIDDLE	1.059	0.5885	1.066	0.6331
	BUSINESS	0.985	0.9046	0.978	0.8885
	SCH.CASTE	0.863	0.2590	0.815	0.1902
	MUSLIMS	1.440	0.3793	1.090	0.8426
HHTYPE	JOINT	.	.	.	.
	NUCLEAR	0.891	0.1371	0.912	0.3311
OCCHH	AGRICULTRE	.	.	.	.
	SERVICE	1.078	0.5411	0.913	0.5448
	DOMESTIC	1.040	0.7257	0.973	0.8445
HOUSE	KACCHA	.	.	.	.
	PUKKA	1.183	0.0931	1.386	0.0043
	MIXED	1.126	0.2589	1.349	0.0181
ECONHH	LOW	.	.	.	.
	MIDDLE	0.964	0.6652	0.979	0.8259
	HIGH	0.919	0.4130	1.002	0.9869
SOCIALHH	LOW	.	.	.	.
	MIDDLE	1.037	0.6949	0.923	0.4400
	HIGH	1.079	0.5731	1.014	0.9307
SEX	MALE	.	.	.	.
	FEMALE	0.894	0.0973	0.961	0.6128
CHALIVE	ALIVE	.	.	.	.
	DEAD	0.318	0.0001	0.191	0.0001
AGECH	0-11	.	.	.	.
	12-23	0.575	0.0112	0.945	0.9404
	24-35	0.645	0.0984	0.925	0.9156
	36+	0.579	0.0299	1.013	0.9865

	LAST CHILD	LAST BUT ONE CHILD
N	1060	767
CENSORED	72	26
-2 LOG L (NULL)	12125.990	8682.909
-2 LOG L (MODEL)	12022.138	8551.628
MODEL CHI-SQ	103.852	131.281
D. F.	42	42
p	0.0001	0.0001

Table 4.2: Two-Way Analysis of CBF vs other Variables

	ALL CASES (n=1060) LAST CHILD			ALL CASES (n=767) LAST BUT ONE CHILD		
VARIABLE	DF	Chi-Sq.Value	Prob.	DF	Chi-Sq.Value	Prob.
FBF	9	129.219	0.001	9	146.952	0.001
PBF	9	796.932	0.001	9	406.871	0.001
PPA	9	108.355	0.001	9	39.089	0.001
FBI	9	50.238	0.001	9	8.704	0.465
OPEN	9	972.470	0.001	9	11.805	0.225
CLOSE	9	13.409	0.145	9	135.275	0.001
PARITY	9	35.363	0.001	9	5.111	0.825
AGECH	9	1240.940	0.001	9	45.315*	0.001
AGEMOTH	6	169.224	0.001	6	6.379	0.382
AGEMOTC	6	46.931	0.001	6	2.435	0.876
AGERM	6	22.814	0.001	6	4.424	0.620
EDUH	9	10.081	0.344	9	14.440	0.108
EDUW	6	16.275	0.012	6	9.085	0.169
RELIGION	3	15.098	0.002	3	3.097	0.377
CASTE	12	23.732	0.022	12	28.221	0.005
HHTYPE	3	4.529	0.210	3	6.069	0.108
OCCHH	6	9.968	0.126	6	8.016	0.237
HOUSE	6	10.160	0.118	6	40.880	0.001
ECONHH	6	19.805	0.003	6	6.297	0.391
SOCIALHH	6	6.311	0.389	6	14.556	0.024
SEX	3	7.900	0.048	3	2.082	0.556
CHALIVE	3	5.560	0.135	3	87.392*	0.001

* Expected frequency in some cells is less than 5.

Table 4.3: Univariate Analysis of the Risk of Weaning - Last and Last but One Child using the Proportional Hazard Model on Selected Variables

	Last child (n = 1060, censored = 485)				Last but one child (n = 767, censored = 45)			
VARIABLE	-2 Log L with covariates	Model chi-square	DF	p	-2 Log L with covariates	Model chi-square	DF	p
NULL	6718.533				8438.870			
FBF	6642.310	76.222	3	0.0001	8316.105	122.765	3	0.0001
PBF	6357.618	360.915	3	0.0001	8180.058	258.812	3	0.0001
PPA	6711.721	6.812	3	0.0781	8429.714	9.156	3	0.0273
FBI	6715.394	3.139	3	0.3707	8437.647	1.223	3	0.7474
OPEN	6715.074	3.459	3	0.3261	8436.793	2.077	3	0.5565
CLOSE	6717.562	0.971	3	0.8083	8390.049	48.821	3	0.0001
PARITY	6715.122	3.410	3	0.3326	8436.270	2.600	3	0.4575
AGEMOTH	6713.269	5.264	2	0.0719	8438.489	0.381	2	0.8266
AGEMOTC	6714.621	3.912	2	0.1414	8438.320	0.550	2	0.7595
AGERM	6710.001	8.531	2	0.0140	8435.081	3.789	2	0.1504
EDUH	6700.812	17.721	3	0.0005	8425.271	13.599	3	0.0035
EDUW	6692.520	26.013	2	0.0001	8433.944	4.926	2	0.0852
RELIGION	6715.910	2.623	1	0.1053	8438.776	0.094	1	0.7590
CASTE	6704.165	14.368	4	0.0062	8425.055	13.815	4	0.0079
HHTYPE	6717.437	1.096	1	0.2951	8434.872	3.998	1	0.0455
OCCHH	6716.764	1.769	2	0.4129	8438.582	0.288	2	0.8659
HOUSE	6712.814	5.718	2	0.0573	8408.612	30.258	2	0.0001
ECONHH	6697.935	20.598	2	0.0001	8434.218	4.653	2	0.0977
SOCIALHH	6708.061	10.471	2	0.0053	8429.670	9.200	2	0.0100
SEX	6718.380	0.152	1	0.6963	8438.866	0.005	1	0.9462
CHALIVE	6694.399	24.133	1	0.0001	8324.173	114.697	1	0.0001
AGECH	6712.511	6.022	3	0.1105	8414.896	23.974	3	0.0001

Table 4.4: Hazard Model Analysis - Combined Breastfeeding

		LAST CHILD		LAST BUT ONE CHILD	
VARIABLE	GROUP	Risk Ratio	p	Risk Ratio	p
FBI	0-17	.	.	.	.
	18-29	1.181	0.2239	0.924	0.5103
	30-41	1.237	0.1284	1.020	0.8730
	42+	1.151	0.3403	0.987	0.9280
PPA	0-2	.	.	.	.
	3-5	1.473	0.0234	1.053	0.7030
	6-8	1.126	0.4297	0.882	0.3245
	9+	0.897	0.2786	0.771	0.0070
OPEN	0-11	.	.		
	12-23	0.863	0.7270		
	24-35	1.757	0.1777		
	36+	3.023	0.0025		
CLOSE	0-23	.	.		
	24-35	0.541	0.0001		
	36-47	0.335	0.0001		
	48+	0.320	0.0001		
PARITY	1-2	.	.	.	.
	3-4	1.067	0.6523	1.204	0.1052
	5-6	1.163	0.3905	1.162	0.3711
	7+	1.347	0.1602	1.277	0.2472
AGEMOT	16-24	.	.	.	.
	25-34	0.701	0.0471	0.901	0.4320
	35+	0.708	0.1336	0.943	0.7470
AGEMOC	10-24	.	.	.	.
	25-34	0.942	0.6824	1.108	0.3900
	35+	0.737	0.1665	1.078	0.7467
AGERM	9-14	.	.	.	.
	15-17	1.036	0.7636	1.003	0.9793
	18+	1.293	0.0864	1.018	0.8988
EDUH	ILLITERATE	.	.	.	.
	PRIMARY	1.340	0.0246	0.981	0.8629
	MID-HIGH	0.855	0.2603	1.054	0.6570
	INTER+	0.966	0.8337	1.088	0.5695
EDUW	ILLITERATE	.	.	.	.
	PRIMARY	1.239	0.1262	0.898	0.3849
	MIDDLE+	1.477	0.0170	0.998	0.9897
RELIGION	HINDU	.	.	.	.
	MUSLIM	0.616	0.4326	0.469	0.0739

TABLE 4.4 (Continued)

VARIABLE	GROUP	LAST CHILD Risk Ratio	LAST CHILD p	LAST BUT ONE CHILD Risk Ratio	LAST BUT ONE CHILD p
CASTE	HIGH	.	.	.	.
	MIDDLE	0.936	0.6287	1.144	0.3276
	BUSINESS	0.809	0.2149	0.995	0.9721
	SCH.CASTE	1.121	0.5109	0.878	0.4091
	MUSLIMS	2.165	0.2211	2.500	0.0441
HHTYPE	JOINT	.	.	.	.
	NUCLEAR	0.945	0.5875	1.094	0.3576
OCCHH	AGRICULTRE	.	.	.	.
	SERVICE	1.236	0.1925	0.904	0.5110
	DOMESTIC	1.103	0.5100	0.895	0.4419
HOUSE	KACCHA	.	.	.	.
	PUKKA	0.903	0.4658	1.175	0.1547
	MIXED	1.002	0.9908	1.187	0.1726
ECONHH	LOW	.	.	.	.
	MIDDLE	0.934	0.5752	0.950	0.6062
	HIGH	1.204	0.1903	1.098	0.4527
SOCIALHH	LOW	.	.	.	.
	MIDDLE	1.126	0.3634	1.068	0.5270
	HIGH	1.213	0.2835	0.930	0.6537
SEX	MALE	.	.	.	.
	FEMALE	1.043	0.6422	0.969	0.6891
CHALIVE	ALIVE	.	.	.	.
	DEAD	0.259	0.0001	0.048	0.0001
AGECH	0-11	.	.	.	.
	12-23	0.799	0.6461	0.240	0.0623
	24-35	0.345	0.0281	0.159	0.0133
	36+	0.254	0.0017	0.150	0.0103

	LAST CHILD	LAST BUT ONE CHILD
N	1060	767
CENSORED	485	45
-2 LOG L (NULL)	6718.533	8438.870
-2 LOG L (MODEL)	6596.888	8149.661
MODEL CHI-SQ	121.645	289.209
D. F.	42	42
p	0.0001	0.0001

Appendix Table 4.A: Survival Analysis of Combined Breastfeeding

CHILD	BLAST	N	% CENSORED	% BREAST FEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST CHILD	0	1060	45.75	1.2	8.7	23.7	37.2	54.5	68.0	25.0	18.2	26.3	36.6	26.8	18.4
L.BUT ONE	1	767	5.87	1.6	16.0	44.9	66.1	83.9	90.0	19.4	13.1	18.5	25.0	18.8	11.9

Variable CHILD	FBF	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST CHILD	0-2	446	47.31	2.2	15.4	37.0	49.4	67.7	80.4	21.9	13.3	24.1	33.1	23.6	19.8
	3-5	220	42.73	1.6	9.9	29.9	46.7	69.4	80.7	23.4	15.7	24.2	30.7	23.7	15.0
	6-8	245	46.94	0.0	3.2	11.8	26.1	40.0	51.4	28.3	21.3	35.4	37.0	32.3	15.7
	9+	149	43.62	0.0	0.0	3.9	15.3	30.1	50.6	30.7	24.9	35.7	46.5	35.7	21.6
L.BUT ONE	0-2	287	2.44	3.8	25.8	58.5	80.1	90.9	95.5	16.8	11.9	15.3	20.6	15.8	8.8
	3-5	186	2.15	0.5	13.4	50.5	71.5	92.5	95.2	18.6	12.8	17.9	24.3	18.2	11.5
	6-8	165	1.21	0.0	13.9	41.8	64.8	86.7	93.3	20.2	14.0	18.7	24.9	19.1	10.8
	9+	129	24.81	0.0	0.8	10.1	28.4	51.2	64.8	26.2	22.2	29.3	36.9	29.4	14.7

CHILD	PBF	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST CHILD	0-5	194	81.96	10.9	43.6	57.2	61.1	61.1	61.1	9.9	9.2	12.9	70.8	26.4	61.6
	6-8	106	49.06	0.0	37.3	84.8	96.2	98.1	98.1	13.0	10.4	12.6	14.4	12.5	4.0
	9-12	172	29.65	0.0	18.3	76.3	96.5	98.2	99.1	14.7	12.3	13.5	16.9	14.0	4.7
	13+	588	37.93	0.0	0.0	3.6	16.2	39.7	57.7	30.0	24.6	32.3	37.8	31.8	13.1
L.BUT ONE	0-5	87	29.89	13.8	56.3	70.1	70.1	70.1	70.1	8.9	8.5	10.9	70.9	25.3	62.5
	6-8	103	0.00	0.0	44.7	91.3	96.1	96.1	96.1	12.1	10.0	12.2	14.0	12.1	4.1
	9-12	190	0.00	0.0	14.7	70.5	93.7	97.9	99.5	15.6	12.6	14.3	18.4	14.9	5.8
	13+	387	4.91	0.0	0.0	14.2	43.4	75.0	85.8	24.6	18.9	24.4	30.0	24.4	11.1

CHILD	PPA	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST CHILD	0-2	478	49.58	1.9	11.5	24.9	36.6	54.0	67.7	24.6	18.0	26.9	36.7	27.1	18.7
	3-5	117	61.54	0.0	17.3	34.7	54.7	68.0	77.8	22.9	13.6	19.9	35.2	22.2	21.5
	6-8	113	46.9	0.0	10.2	30.8	46.3	59.7	73.7	23.9	15.8	24.6	36.3	25.3	20.5
	9+	352	34.94	1.2	3.6	18.5	32.2	51.3	65.1	26.3	18.8	28.5	36.7	28.1	18.0
L.BUT ONE	0-2	373	8.04	2.7	22.0	48.3	70.8	86.2	89.5	18.1	12.4	18.2	24.5	18.3	12.2
	3-5	78	6.41	0.0	16.7	66.7	78.2	87.4	93.6	16.9	12.5	15.6	22.5	16.5	10.0
	6-8	87	5.75	0.0	13.8	43.7	65.5	83.9	90.8	19.5	13.6	18.5	26.1	19.2	12.5
	9+	229	2.18	0.9	7.0	32.3	54.6	79.0	89.1	21.9	15.8	20.8	26.9	21.1	11.1

Appendix Table 4.A (Continued)

CHILD	FBI	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST CHILD	0-17	214	50.93	2.1	13.9	25.8	39.4	59.0	74.2	23.8	17.5	25.0	36.2	25.9	18.7
	18-29	293	50.85	1.1	7.1	26.4	42.0	56.5	71.1	23.8	16.6	24.7	36.5	25.6	19.9
	30-41	256	43.75	0.8	8.9	26.6	41.1	56.4	71.6	24.2	16.6	25.6	36.3	26.0	19.7
	42+	297	38.72	1.1	6.7	17.3	28.7	48.7	59.2	27.4	19.0	30.3	36.9	29.1	17.9
L.BUT ONE	0-17	153	6.54	2.6	17.6	46.4	70.6	85.1	90.5	18.6	12.6	18.3	24.5	18.5	11.9
	18-29	217	7.37	0.5	15.7	50.3	66.6	82.6	88.3	19.0	13.3	17.9	25.8	18.8	12.4
	30-41	199	4.52	1.5	18.6	44.2	64.3	84.7	91.2	19.5	12.8	18.6	25.3	18.8	12.5
	42+	198	5.05	2.0	12.6	38.4	63.9	83.5	90.4	20.2	13.5	18.9	25.2	19.2	11.8

CHILD	OPEN	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST CHILD	0-11	245	93.06	1.2	20.2	37.1	37.1	47.6	47.6	18.8	13.6	38.2	70.7	40.2	57.1
	12-23	215	70.23	0.5	5.7	22.1	44.1	57.7	72.8	23.9	18.3	24.4	37.2	26.1	18.9
	24-35	156	43.59	1.3	5.4	20.3	31.7	52.0	62.6	25.5	18.9	28.7	46.3	30.7	27.4
	36+	444	8.56	1.6	9.8	24.8	37.8	54.8	68.7	24.9	18.0	25.8	36.5	26.5	18.5
L.BUT ONE	0-11	185	7.03	0.5	14.6	39.5	59.4	79.0	87.9	21.3	13.5	19.0	27.4	19.7	13.9
	12-23	167	8.98	1.8	18.6	50.3	71.3	85.1	88.2	17.7	12.6	17.9	24.5	18.2	11.9
	24-35	145	5.52	1.4	17.2	40.7	63.4	86.2	92.7	19.4	13.3	19.0	25.0	19.0	11.7
	36+	270	3.33	2.2	14.8	47.4	68.9	85.2	91.2	19.1	13.1	18.3	24.6	18.6	11.5

CHILD	CLOSE	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST CHILD	0-23	318	52.20	1.4	9.8	21.1	36.3	55.6	67.0	24.8	18.6	25.6	37.0	26.7	18.4
	24-35	409	46.70	0.5	7.4	25.2	37.2	54.8	70.2	24.6	17.8	25.9	36.4	26.5	18.6
	36-47	180	40.00	1.2	8.3	28.3	39.8	53.1	66.8	25.6	16.2	28.4	36.5	27.4	20.3
	48+	153	36.60	2.8	10.5	19.5	36.1	54.0	66.0	25.6	18.6	27.1	36.9	27.4	18.3
L.BUT ONE	0-23	222	10.36	3.6	32.0	69.9	82.9	87.9	91.1	14.6	10.8	13.7	18.7	14.2	7.9
	24-35	324	4.32	0.9	11.1	38.3	68.5	90.4	94.1	19.3	15.1	18.9	24.6	19.4	9.5
	36-47	133	3.76	0.0	4.5	25.6	45.1	73.7	88.0	23.5	17.6	24.4	30.2	24.2	12.5
	48+	88	3.41	1.1	11.4	35.2	46.6	63.6	73.0	23.7	13.6	24.3	36.2	24.6	22.6

CHILD	PARITY	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST CHILD	1-2	313	53.67	1.8	10.5	26.6	40.1	61.4	75.7	23.9	16.5	24.9	35.8	25.5	19.3
	3-4	348	43.68	0.9	9.5	24.9	39.4	54.7	68.4	24.6	18.0	25.6	36.7	26.5	18.7
	5-6	239	39.75	1.3	8.6	24.6	35.5	51.5	61.5	25.4	18.1	28.2	36.9	27.9	18.9
	7+	160	43.75	0.7	4.2	15.0	30.9	49.2	66.1	27.0	20.6	30.1	36.6	29.4	16.0
L.BUT ONE	1-2	296	7.77	1.7	13.9	41.9	64.8	82.5	89.8	19.4	13.5	18.8	25.7	19.2	12.2
	3-4	262	3.05	1.5	17.9	47.7	66.0	86.7	91.6	19.2	12.7	18.2	24.8	18.5	12.2
	5-6	124	6.45	1.6	15.3	46.0	70.2	84.9	89.9	19.5	13.3	18.3	24.6	18.6	11.4
	7+	85	7.06	1.2	18.8	44.7	65.1	78.4	86.1	19.8	13.2	19.1	26.1	19.4	12.9

Appendix Table 4.A (Continued)

CHILD	AGECH	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST CHILD	0-11	245	95.10	1.3	16.7	44.5	44.5	72.2	72.2	16.7	13.3	24.2	71.0	33.2	57.7
	12-23	208	69.71	0.5	6.7	25.6	48.1	61.1	87.0	22.2	17.7	24.1	34.1	25.0	16.4
	24-35	142	45.07	0.7	4.9	19.0	31.7	50.8	64.5	22.1	19.5	29.4	70.8	37.3	51.3
	36+	465	9.25	1.7	9.9	24.3	36.8	54.2	67.1	24.9	18.1	25.9	36.7	26.7	18.6
L.BUT ONE	0-11	2	0.00	0.0	50.0	50.0	50.0	50.0	50.0	6.5	6.5	7.0	70.5	22.8	64.0
	12-23	27	11.11	3.7	29.6	70.9	93.5	93.5	93.5	14.0	11.4	14.5	18.4	14.7	7.0
	24-35	116	9.48	2.6	26.7	51.7	75.9	88.1	92.9	16.6	11.8	17.3	22.8	17.3	11.0
	36+	622	4.98	1.3	13.2	42.3	63.2	82.5	89.1	19.9	13.5	18.8	26.0	19.3	12.5

CHILD	AGEMOTH	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST CHILD	16-24	283	68.55	2.1	9.8	28.0	44.3	72.2	83.3	22.2	16.4	24.4	30.7	24.0	14.3
	25-34	422	54.27	0.5	9.0	25.0	36.9	50.2	67.0	25.0	18.0	29.9	36.9	28.6	18.9
	35+	355	17.46	1.4	7.8	20.6	34.6	52.9	65.2	25.7	18.5	26.8	36.7	27.2	18.2
L.BUT ONE	16-24	165	9.70	3.6	20.0	46.7	70.1	85.4	90.2	17.9	12.6	18.3	24.8	18.5	12.1
	25-34	397	5.54	0.8	14.1	44.6	66.3	84.5	90.0	19.5	13.2	18.5	24.9	18.8	11.7
	35+	205	3.41	1.5	16.6	43.9	62.4	81.5	88.3	20.1	13.2	19.0	25.9	19.2	12.7

CHILD	AGEMOTC	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST CHILD	10-24	450	55.78	1.5	10.3	26.3	40.3	61.5	74.1	23.5	17.0	24.8	36.1	25.7	19.1
	25-34	507	38.86	1.2	8.2	23.4	36.6	52.2	66.7	25.3	18.2	27.1	36.7	27.3	18.5
	35+	103	35.92	0.0	5.3	16.5	29.9	45.5	56.3	27.9	21.1	32.1	40.2	31.4	19.1
L.BUT ONE	10-24	423	5.91	1.7	15.6	43.8	66.4	84.4	90.8	19.2	13.3	18.6	25.2	18.9	11.9
	25-34	303	5.94	1.6	16.2	45.9	66.1	84.7	89.5	19.4	12.9	18.4	24.8	18.6	11.9
	35+	41	4.88	0.0	19.5	48.8	63.4	73.2	85.4	20.3	13.1	19.3	30.2	20.5	17.1

CHILD	AGERM	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST CHILD	9-14	206	39.32	1.5	7.3	20.0	30.4	44.9	59.2	27.3	19.0	30.7	36.9	29.3	17.9
	15-17	570	48.95	0.7	8.3	23.3	36.4	53.8	66.4	25.1	18.3	27.3	36.7	27.4	18.4
	18+	284	44.01	2.0	10.6	27.5	44.7	64.7	78.7	23.0	15.7	24.4	32.9	24.4	17.3
L.BUT ONE	9-14	146	4.11	1.4	13.0	39.1	64.0	79.4	89.6	20.6	13.4	18.8	28.3	19.8	14.8
	15-17	420	6.90	1.7	15.5	43.8	64.6	84.1	89.8	19.3	13.4	18.7	25.0	19.0	11.5
	18+	201	4.98	1.5	19.4	51.3	70.9	86.6	90.6	18.6	12.5	17.6	24.5	18.0	12.0

CHILD	EDUH	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST	ILLITERATE	313	47.60	1.0	9.4	22.8	35.0	47.6	63.1	25.4	18.4	30.3	38.3	29.3	19.9
CHILD	PRIMARY	217	47.00	1.5	8.8	23.9	40.9	57.3	69.8	25.3	18.2	24.9	36.5	26.1	18.3
	MID-HIGH	268	50.37	0.8	5.7	23.5	31.4	46.7	60.2	26.1	18.5	30.4	36.9	29.1	18.4
	INTER+	262	37.79	1.6	10.8	24.9	42.5	67.7	79.3	23.6	18.0	24.4	34.0	25.2	16.0
L.BUT	ILLITERATE	245	8.57	0.8	13.5	39.6	60.6	77.2	84.5	20.4	13.7	19.5	28.4	20.3	14.7
ONE	PRIMARY	171	6.43	1.2	15.8	45.7	66.3	83.8	90.2	19.6	13.2	18.6	26.2	19.2	13.0
	MID-HIGH	199	4.52	2.0	17.1	48.2	68.4	86.8	92.6	18.8	13.0	18.2	24.7	18.5	11.7
	INTER+	152	2.63	2.6	19.1	48.0	71.7	90.9	95.4	18.3	12.4	18.2	24.3	18.3	11.8

Appendix Table 4.A (Continued)

CHILD	EDUW	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST	ILLITERATE	703	48.22	0.8	7.9	21.3	33.3	48.0	62.3	26.1	18.7	30.3	37.0	29.1	18.3
CHILD	PRIMARY	158	42.41	2.7	10.0	28.6	37.7	60.8	69.1	24.3	15.1	24.8	36.4	25.3	21.3
	MIDDLE+	199	39.70	1.6	10.5	28.8	51.6	73.7	87.2	22.0	14.9	22.2	30.2	22.4	15.4
L.BUT	ILLITERATE	532	6.20	1.5	16.4	43.4	63.7	82.1	88.8	19.7	13.3	18.8	26.0	19.2	12.8
ONE	PRIMARY	109	6.42	1.8	12.8	51.4	69.7	86.2	90.0	18.5	12.9	17.5	25.7	18.4	12.7
	MIDDLE+	126	3.97	1.6	17.5	45.2	73.3	89.5	95.1	18.5	12.7	18.3	24.1	18.4	11.5

CHILD	RELIGION	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST	HINDU	946	44.50	1.1	8.1	23.0	36.3	53.7	66.9	25.3	18.3	26.9	36.7	27.2	18.4
CHILD	MUSLIM	114	56.14	2.0	14.2	30.3	46.7	64.2	79.8	22.3	16.2	24.4	33.3	24.6	17.1
L.BUT	HINDU	672	5.80	1.6	15.9	44.2	65.8	84.5	90.7	19.4	13.1	18.6	24.9	18.8	11.8
ONE	MUSLIM	95	6.32	1.1	16.8	49.5	68.4	80.0	85.3	19.3	12.9	18.2	26.3	18.9	13.4

CHILD	CASTE	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST	HIGH	221	31.22	2.4	11.9	27.3	42.6	63.7	78.6	23.0	15.5	24.5	34.5	24.7	19.0
CHILD	MIDDLE	389	45.50	0.3	6.2	21.8	34.1	51.1	64.5	26.1	18.6	28.6	36.7	28.1	18.1
	BUSINESS	155	54.19	1.4	6.5	16.8	27.6	44.0	57.6	28.1	19.9	32.6	38.0	30.8	18.1
	SCH.CASTE	187	51.34	1.1	8.6	25.4	39.9	52.2	60.9	24.8	16.8	28.0	37.5	27.6	20.8
	MUSLIMS	108	54.63	2.1	14.6	29.7	47.1	66.0	82.2	22.2	16.1	24.3	32.4	24.3	16.3
L.BUT	HIGH	125	4.80	3.2	22.4	48.8	68.8	85.0	91.9	18.4	12.3	18.2	24.6	18.3	12.3
ONE	MIDDLE	290	4.83	1.7	19.0	47.6	69.4	86.9	93.1	18.7	12.7	18.2	24.6	18.4	11.9
	BUSINESS	112	3.57	0.0	9.8	47.3	63.4	85.9	92.9	20.3	13.9	18.4	26.4	19.3	12.5
	SCH.CASTE	150	10.67	1.3	9.3	30.7	56.5	77.3	82.3	21.3	15.5	20.9	27.6	21.2	12.1
	MUSLIMS	90	5.56	1.1	16.7	51.1	71.1	81.1	86.7	18.8	12.7	17.5	24.9	18.1	12.2

CHILD	HHTYPE	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST	JOINT	502	45.02	1.1	9.7	24.8	36.0	52.5	65.6	25.5	18.0	28.2	36.8	27.8	18.8
CHILD	NUCLEAR	558	46.42	1.4	7.8	22.5	38.5	56.6	70.2	24.6	18.3	25.0	36.4	26.2	18.1
L.BUT	JOINT	402	6.72	1.0	13.4	43.8	63.5	81.0	88.5	19.8	13.4	18.8	26.1	19.3	12.7
ONE	NUCLEAR	365	4.93	2.2	18.9	46.1	69.0	87.1	91.6	18.9	12.7	18.3	24.7	18.5	12.0

CHILD	OCCHH	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST	AGRICULTRE	122	43.44	4.5	12.6	25.7	34.4	48.9	65.3	23.6	17.4	30.1	36.9	28.6	19.5
CHILD	SERVICE	334	50.30	1.3	11.4	25.6	38.4	52.2	68.3	24.9	17.6	27.5	36.8	27.3	19.3
	DOMESTIC	604	43.71	0.5	6.5	22.3	37.1	56.8	68.3	25.5	18.4	25.2	36.5	26.3	18.2
L.BUT	AGRICULTRE	78	8.97	2.6	21.8	53.8	70.5	82.3	86.6	18.0	12.3	16.7	25.2	17.7	13.0
ONE	SERVICE	269	6.32	1.5	16.7	44.6	66.3	82.0	87.9	19.5	13.3	18.7	25.2	19.0	11.9
	DOMESTIC	420	5.00	1.4	14.5	43.4	65.2	85.4	92.1	19.5	13.2	18.6	24.9	18.8	11.7

Appendix Table 4.A (Continued)

CHILD	HOUSE	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST	KACCHA	242	45.45	2.6	12.3	24.3	36.2	49.5	65.6	25.1	18.1	30.1	37.2	28.9	19.1
CHILD	PUKKA	338	54.44	0.0	4.6	19.9	37.7	50.3	61.5	25.8	18.6	28.9	36.9	28.3	18.3
	MIXED	480	39.79	1.3	9.7	26.0	37.6	59.5	72.6	24.5	17.4	24.9	36.2	25.8	18.9
L.BUT	KACCHA	183	11.48	1.1	12.0	31.7	50.4	71.1	79.1	21.8	15.1	23.2	30.8	23.1	15.6
ONE	PUKKA	253	4.35	0.8	17.0	47.4	68.2	86.2	93.5	19.4	12.8	18.3	25.1	18.6	12.3
	MIXED	331	3.93	2.4	17.5	50.2	73.1	89.2	93.4	18.1	12.8	18.0	24.2	18.2	11.4

CHILD	ECONHH	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST	LOW	270	55.19	0.4	10.1	27.4	40.1	48.5	64.4	24.1	16.4	30.2	38.7	28.9	22.3
CHILD	MIDDLE	442	49.55	2.4	9.8	21.5	31.6	49.6	63.3	25.4	18.8	30.1	39.3	29.6	20.5
	HIGH	348	33.62	0.3	6.4	23.8	41.7	63.9	75.4	24.9	18.1	24.5	35.7	25.7	17.6
L.BUT	LOW	218	6.42	0.5	14.2	43.6	66.7	82.7	87.6	19.7	13.2	18.6	25.2	18.9	12.0
ONE	MIDDLE	341	7.33	2.1	16.7	43.7	63.2	81.2	89.4	19.6	13.0	18.7	26.5	19.2	13.4
	HIGH	208	2.88	1.9	16.8	48.1	70.2	89.5	93.5	18.6	12.9	18.2	24.4	18.4	11.5

CHILD	SOCIALHH	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST	LOW	318	52.52	1.6	10.6	25.0	36.9	51.9	64.9	24.5	17.0	28.1	37.1	27.6	20.1
CHILD	MIDDLE	433	51.04	0.8	6.6	20.7	33.2	49.1	65.2	26.3	19.0	30.1	36.8	29.0	17.8
	HIGH	309	31.39	1.4	9.7	26.3	42.5	63.0	73.7	23.9	16.7	24.6	36.1	25.5	19.5
L.BUT	LOW	255	7.45	1.2	12.5	37.7	58.2	79.5	86.6	20.6	13.7	19.7	27.4	20.1	13.7
ONE	MIDDLE	323	7.12	0.9	18.0	49.8	70.2	84.4	89.9	18.8	12.8	18.0	24.9	18.4	12.1
	HIGH	189	1.59	3.2	17.5	46.0	69.8	88.9	94.7	18.7	12.8	18.3	24.4	18.5	11.6

CHILD	SEX	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST	MALE	588	41.50	1.1	9.2	23.5	36.4	52.5	67.2	25.2	18.2	27.4	36.6	27.4	18.4
CHILD	FEMALE	472	51.06	1.4	8.0	24.0	38.4	57.6	69.1	24.8	18.1	25.0	36.7	26.2	18.6
L.BUT	MALE	422	5.69	0.9	14.9	45.3	67.4	83.5	90.5	19.3	13.2	18.5	24.9	18.8	11.6
ONE	FEMALE	345	6.09	2.3	17.4	44.4	64.5	84.4	89.4	19.5	12.9	18.7	25.1	18.8	12.2

CHILD	CHALIVE	N	% CENSORED	% BREASTFEEDING AT MONTHS 6	12	18	24	30	36	SUMMARY MEASURES (MONTHS) MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST	ALIVE	1012	44.27	1.3	9.0	24.3	37.8	55.1	68.9	25.1	18.1	25.9	36.5	26.6	18.4
CHILD	DEAD	48	77.08	0.0	2.8	9.2	21.5	40.0	45.0	21.4	24.2	70.9	70.3	59.1	46.1
L.BUT	ALIVE	729	2.06	1.6	16.6	46.7	68.7	86.8	92.9	19.2	12.9	18.3	24.7	18.6	11.7
ONE	DEAD	38	78.95	0.0	5.3	10.5	16.0	21.7	21.7	16.6	70.8	69.7	68.5	69.7	-2.3

Appendix Table 4.B: Survival Analysis of Full Breastfeeding

			% BREASTFEEDING	AT MONTHS					SUMMARY MEASURES (MONTHS)					
CHILD	N	CENSORED	1	3	6	9	12	18	MEAN	Q1	Q2	Q3	TM	Q3-Q1
LAST	1060	6.79	11.1	40.7	60.6	84.4	92.3	96.7	5.1	1.9	4.2	7.3	4.4	5.4
L.BUT ONE	767	3.39	9.5	37.4	61.7	83.2	90.7	94.8	5.0	1.9	4.4	7.5	4.5	5.6

Figure 4.1: Percentage Distribution of Duration of Breastfeeding

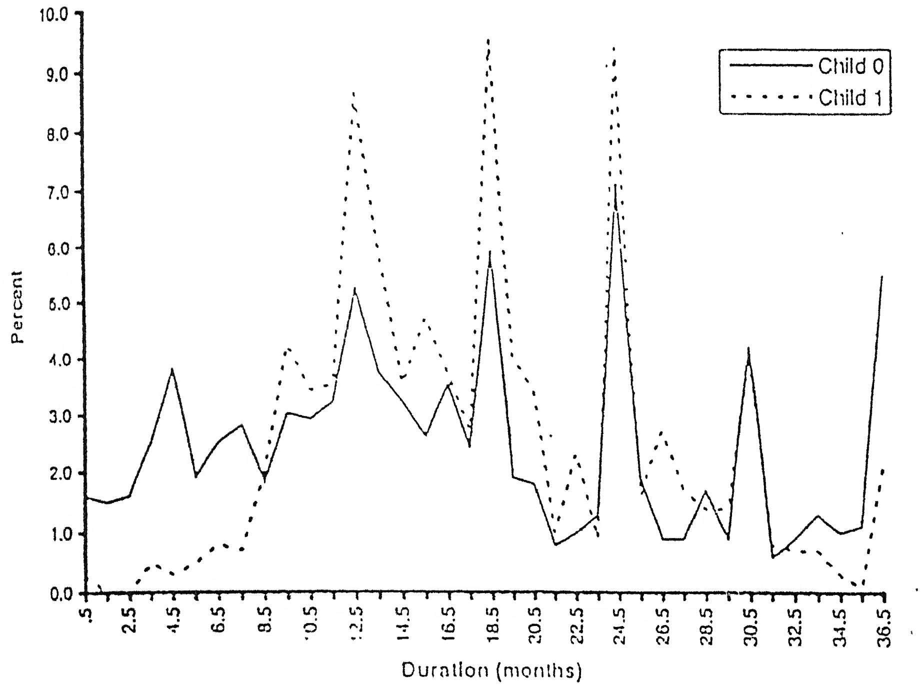


Figure 4.2: Percentage Distribution of Duration of Full Breastfeeding

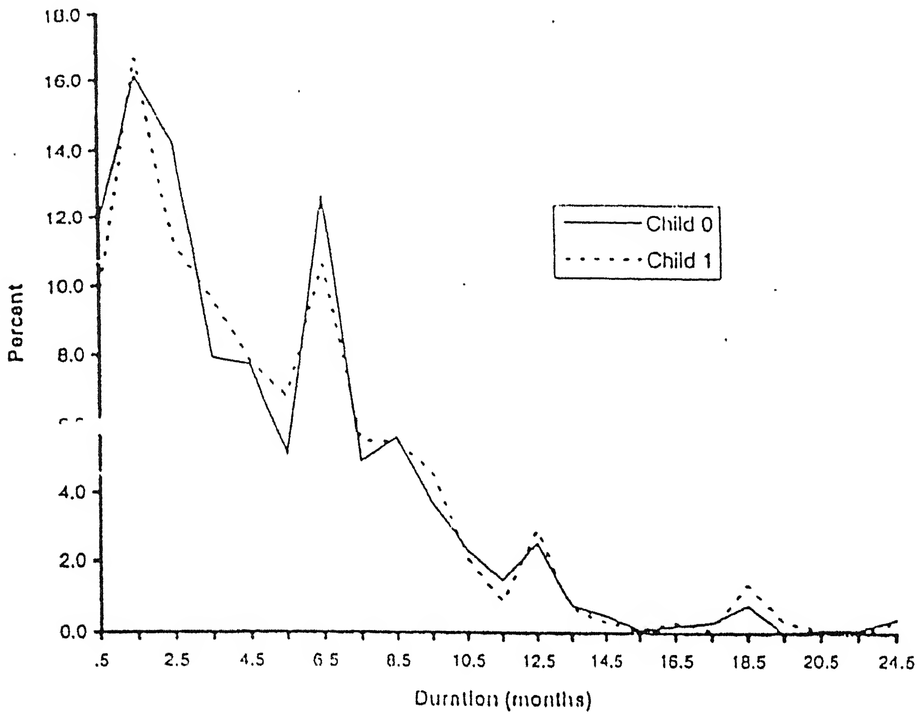


Figure 4.3: **Survival Curves based on Life Table Analysis**

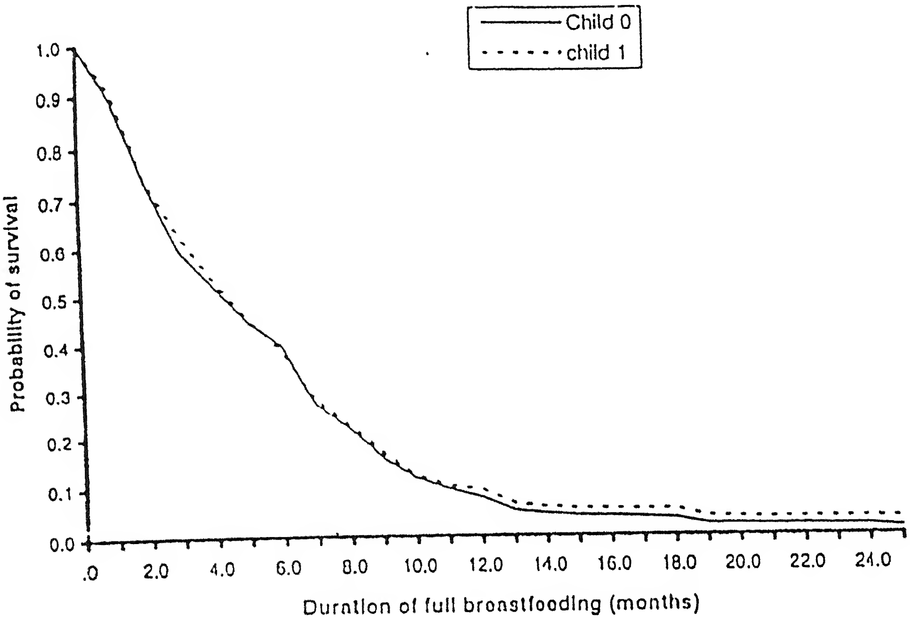


Figure 4.4: Survival Curves based on Life Table Analysis

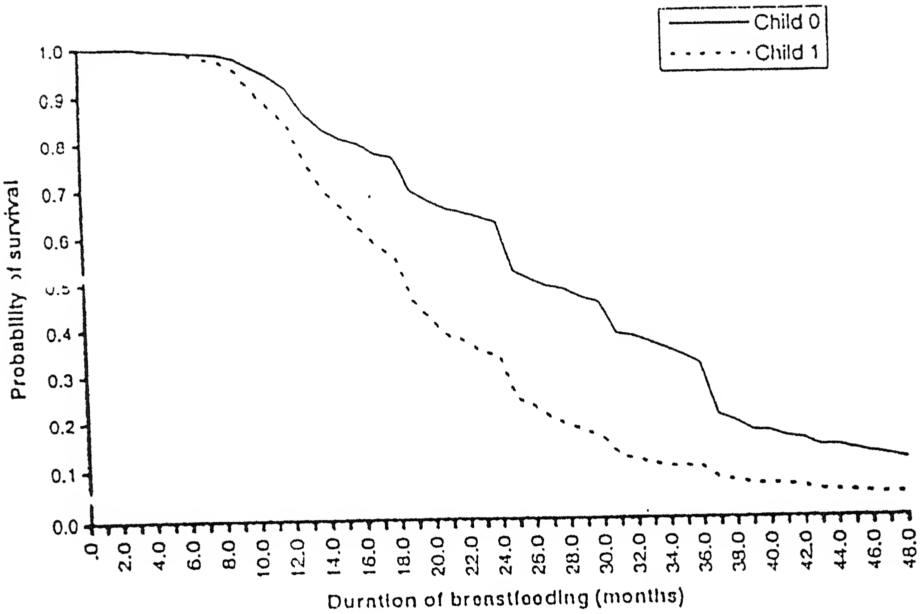


Figure 4.5: Mean Duration of Breastfeeding by Characteristics of Women

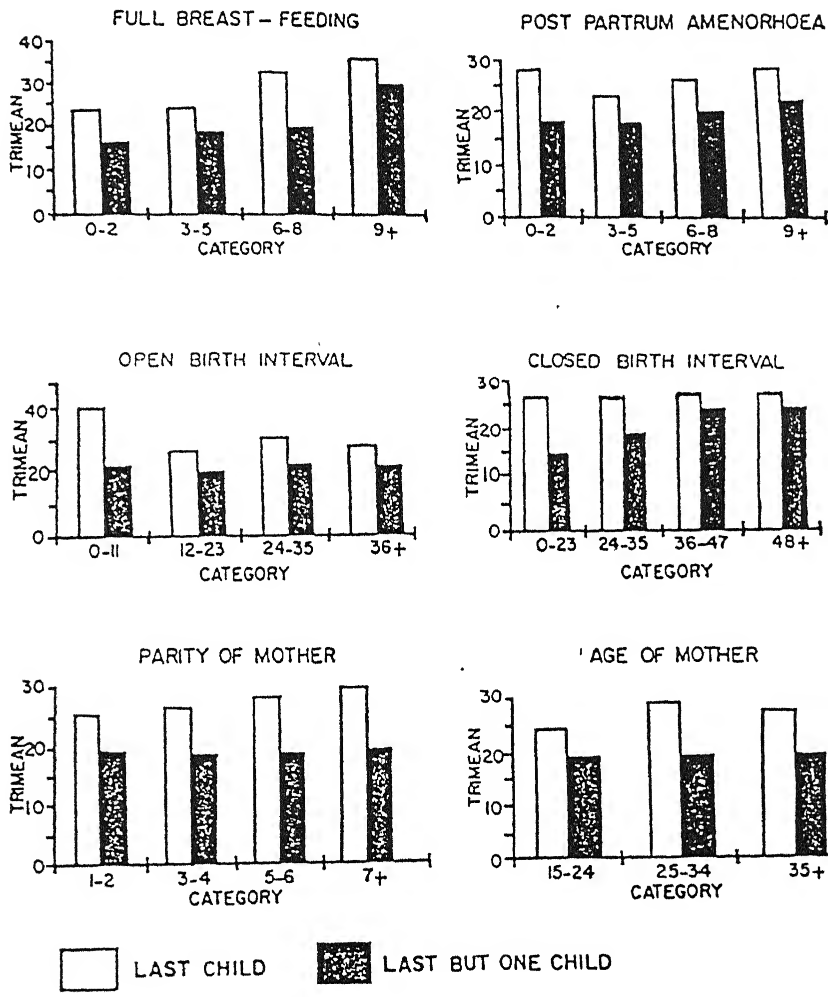
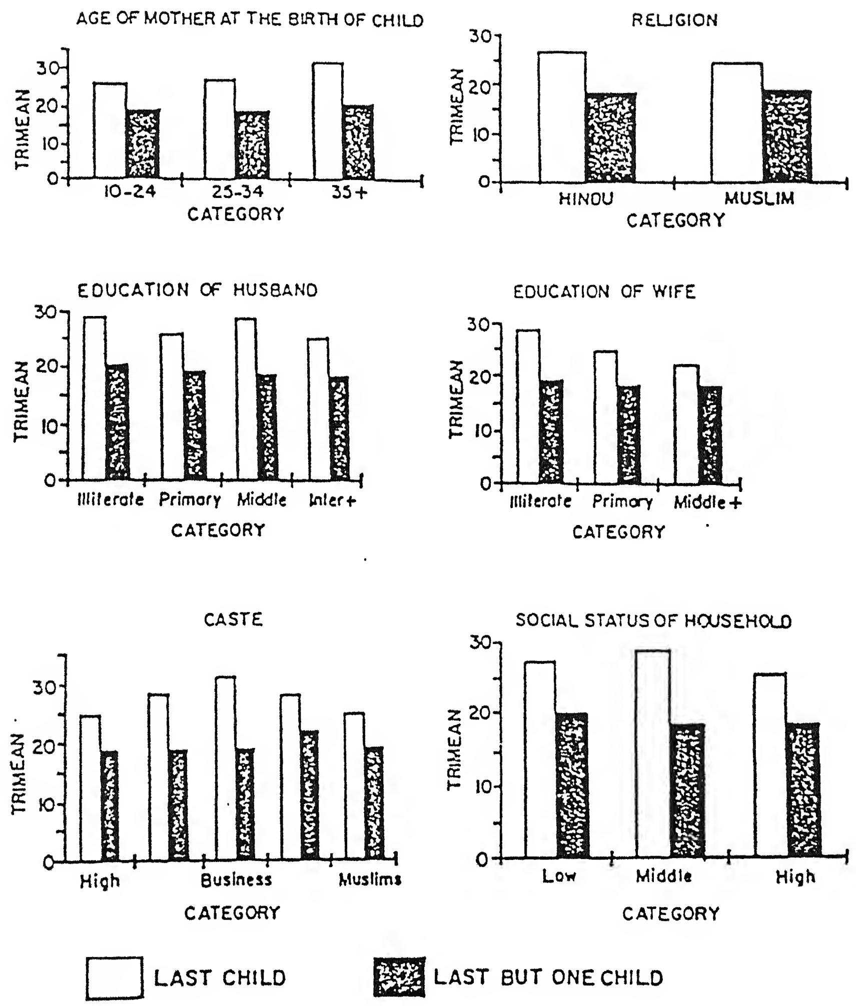


Figure 4.5: (Continued)



CHAPTER - V

CHAPTER-V

CORRELATES OF BIRTH INTERVALS: A HAZARD MODEL ANALYSIS

5.1 Introduction

An analysis of birth interval data to study the process of reproduction is well documented and it provides rich and more detailed information about the reproductive behavior than do the data on the number of births (Bogue and Bogue, 1980; Henry, 1961). The analysis of birth interval data, for example, provides information on the progression from one parity to another as well as the timing of this transition (Roderiguez and Hobcraft, 1980 and Yadava *et al.*, 1992).

As discussed in chapter III, the trends and differentials in fertility of a particular community are governed by a composite result of the interaction of intermediate variables, leading to a variation in the chance of conception and live birth. The important intermediate variables viz.: marriage, contraception, fetal loss, and prevalence of the pattern of breastfeeding and post partum infertility period, all together determine the length of a birth interval (Bongaarts 1978; Davis and Blake 1956; Jain *et al.*, 1979 and Srinivasan *et al.*, 1989). Further, all these intermediate variables, within a given length of birth interval, have varying effects on the duration of birth interval depending on several socio-economic, demographic, and cultural characteristics of the mothers (Bhattacharya *et al.*, 1987, 1994; Nath *et al.*, 1994). It has been noted that if fecundability is substantially reduced by continuing breastfeeding beyond the resumption of menstruation, it has important bearing on the analysis and understanding of birth interval components, and for the assessment of the role of the proximate determinants in reducing fertility (Guz and Hobcraft, 1991).

As said in chapter I, a birth interval in the Indian context is a mixed and complicated result of biological (fecundity, post partum amenorrhoea) and sociological (breastfeeding, abstinence, cultural and religious taboos) factors (Battacharya *et al.*, 1987, 1994; Nath *et al.*, 1994). Moreover, biological factors (fecundity, primary sterility (adolescent sterility), and secondary sterility (after menopause)) and sociological factors (such as marriage age, abstinence, contraception, and breastfeeding) have varying effects on the duration of birth intervals. Recently, various types of birth interval, namely, first birth interval, closed birth interval, open birth interval, straddling birth interval are widely used to estimate the level of fecundability (probability of conception in one menstrual cycle) as well as for detecting current changes in fertility patterns of women (Sharma and Mishra, 1978; Yadava *et al.*, 1993). Among these, first birth interval (interval from marriage to first birth) marks an important step in the life cycle of a woman and it provides fertility performance of a couple in the beginning of their married life. A number of studies have been conducted on differentials and determinants of first birth interval in different regions of developing as well as developed countries (Kumar and Upadhya, 1999; Roy, 1991; Singh and Yadava, 1981; Yadava.1989; Yusuf, 1985). Rajaram *et al.* (1994) have studied a parity specific analysis of birth interval dynamics in Goa and found the main source of variation in the timing of first birth as the age at marriage, level of education, use of contraception and socio-economic status of the household a woman comes from. It has also been found that woman from low, low-middle and middle socio-economic status tend to have shorter birth intervals than women from very high socio-economic groups (Singh *et al.*, 1993).

This chapter examines the effects of a number of demographic, socio-economic and cultural variables, as proximate determinants of fertility, on the length of birth intervals analyzed through both the univariate and multivariate proportional hazard models. The first birth interval and last closed birth interval are discussed. In fact these two birth intervals influence the fertility behavior in the early as well as in the late stage of the reproductive span of a

couple. The first birth interval has been studied in respect to the *last* child, and the last closed birth interval is studied in respect to the *last but one* child.

5.2 Data and Methodology

The data for this chapter have also taken from the sample survey entitled " Effect of Breastfeeding on Fertility in Northern India- A Sample Survey - 1995.The questionnaire was designed in such a way to have information for the inter-relationships among three variables- breastfeeding, post partum amenorrhoea, and birth intervals - all of which influence fertility. Besides other informations, a separate section in the schedule was devoted to seeking additional information on births, particularly the *last* and the *last but one* births that occurred to couples in the households preceding the survey date of March 1995. Married women, aged under 50 years and living with their husbands at the survey date, provided the fertility, breastfeeding, post partum amenorrhoea, birth intervals, and family planning information.

For details about survey's data see section 3.2 of chapter 3 and also Appendix I.

Univariate and multivariate statistical techniques have been used to study the differentials in the durations of first birth interval (FBI) and last closed birth interval (LCBI). For the bivariate analysis, the lengths of FBI and LCBI are grouped into monthly intervals as 0 - 17, 18 - 29, 30 - 41, 42+ months and 0 - 23, 24 - 35, 36 - 47, 48+ months respectively. All the other explanatory variables have been grouped into categories as shown in Table 5.2. Assuming that breastfeeding started just after the birth, the censored cases of the duration of breastfeeding have been allocated a duration equal to the age of the child at survey date. The mean duration of FBI and LCBI is calculated from ungrouped data after making them continuous variables.

The univariate proportional hazard model analysis is used to obtain a measure of the effect of each variable on the duration-specific probabilities of the resumption of next event (hazard function) in the absence of the control for other variables. A multivariate proportional hazard model analysis is then undertaken to provide a measure of the effect of each category of each variable on the hazard function while controlling for the effects of other covariates. A hazard model is an appropriate method for the analysis of failure times in the presence of the type of censoring usually encountered in retrospective survey data. A hazard model is defined as

$$\lambda_x(t) = \lambda_0(t)\, C_x$$

Where $C_x = e^{\sum b_i x_i}$; λ_0 denotes the baseline hazard function, C_x is a multiplier specific to persons with a set of X, bi's are the regression coefficients, and Xi's are the independent variables (or a set of covariates). A hazard rate refers to the probability of occurrence of an event within an infinitesimally small interval, given that this event has not occurred before the start of that interval. For analysis of such data, an ordinary least square regression may not be a suitable technique as one has to drop those women (respondents) from the analysis who have not completed the birth interval, whereas the hazard analysis makes optimal use of information on whether or not a woman has completed its birth interval. Further, in an ordinary life table analysis, a population is assumed to be homogenous where each sample member has the same hazard function whereas in a proportional hazard model, the hazard is not only the function of time but also a function of specified predictor variable. Thus the proportional hazard model allows for a certain amount of heterogeneity. Moreover, multivariate hazard model analyses are used to avoid biases resulting from each censoring as well as if the distribution is marked by heaping at certain points in time such as 6 or 12 (Liefbroer and henkens, 1999).

The chi-square statistic has also been used to test the goodness-of-fit of the model as well as to test the significance of the explanatory variables. Some

explanatory variables, which were inter-related, were excluded from the multivariate hazard modeling to avoid the effect of multicollinearity.

5.2.1 The dependent and independent variables

The duration of FBI - the interval between the first birth and the time of marriage, and LCBI- time period between the penultimate child and the most recent child have been measured in completed months and are used as the dependent variables. The independent variables, all measured retrospectively at the survey date are classified into three categories: demographic, socio-economic and cultural variables.

Demographic variables included are: post partum amenorrhoea, breastfeeding, age of mother, age of mother at the birth of the child, age at return marriage, parity of mother, age of child, survival status of child, and sex of child.

Socio-economic variables included are: type of household, status of house, main occupation of the household, economic status of the household, social status of the household, education of wife, and education of husband.

Cultural variables: The two variables included religion (Hindu or Muslim) and caste.

The measurements of these demographic, socio-economic and cultural variables are given in chapter III.

5.3 Results and Discussion

5.3.1 Distributions of FBI and LCBI

Figure 5.1 gives the percentage distribution of the duration of FBI based on the data of the last child. The data indicate heaping in the multiple of 6 and 12 months. Along with the reporting errors due to high rate of illiteracy among the respondents, prevalence of social and cultural taboos in the region of study seems to play a major role in the zig-zag distribution of FBI. Moreover, many females enter conjugal relations while in the state of adolescent subfecundity (Bhattacharya *et al.*, 1987). The separation of partners just after a few days of the return-marriage is a custom, particularly among Hindus. In majority of cases, a female returned to her parent's home after a stay of one week or less at her in-laws house after marriage. The next time after the first visit, she comes to her in-laws house only after 1, 2 or 3 years, at a date known as 'lucky date" usually given by a spiritual person (such as a priest or an elderly) in consultation with the parents of both partners - bride and bridegroom. The chance of conception therefore may be distributed or shared among all the parties involved. The raw distribution of the FBI indicated that about one-fifth (21%) of the eligible couples have to wait to be parents for a more than 48 months after the marriage.

Figure 5.2 shows the distribution of the duration of LCBI. The distribution of LCBI revealed two modal points at 24 and 36 months. About 10% of the mothers were found to have reported their LCBI of more than 48 months.

5.3.2 The mean length of FBI and LCBI

The mean duration of FBI and LCBI, although affected by the extreme duration values, were 36.2 and 32.2 months, respectively. The median duration of FBI and LCBI were found 30.5 and 29.5 months, respectively. The mean duration of FBI reported in other studies of rural Uttar Pradesh

was about 44 months while that of LCBI was found about 30 and 32 months (Singh 1993; Singh *et al.*, 1993). A shorter duration of FBI found in this study may be due to an increasing age at marriage over time in India, particularly during the last two decades when a legalisation act for the age of marriage was passed by the Indian government. Besides other reasons, adolescent sterility has been found an important factor for an increased first birth interval among women who married at early ages, say below 14 years. The effect of modernization may be another reason for the shorter duration of FBI where a couple likes to complete his family cycle as soon as possible. However, the mean duration of birth intervals found in Indian studies is higher compared to Western countries. Social and cultural taboos and customs are the main factors behind it. For example, sexual abstinence is generally observed, particularly among Hindus, during occasions of religious festivals (such as new moon days, full moon days). Such types of abstinence vary from 1 to 120 days per year in India depending on the region of the country (Samuel, 1971). Nevertheless, to get a clearer idea, we examine below the effects of the explanatory variables being controlled for.

5.3.3 Birth intervals and Demographic variables

5.3.3.1 Birth intervals in relation to breastfeeding and post partum amenorrhoea

The role of breastfeeding in increasing the waiting time for the next conception through post partum-amenorrhoea has been well documented. Substantial variation in the length of birth interval in response to the duration of breastfeeding and post partum amenorrhoea has been noted in several studies (Anh *et al.*, 1995; Mannan and Islam 1995; Nath *et al.*, 1994; Page *et al.*, 1982; Singh 1993; Srinivasan *et al.*, 1989; Trussell *et al.*, 1992; Yadava and Jain, 1998). It has been found that in societies where mothers practice a prolonged and on- demand breastfeeding, birth intervals tend to be longer. Some studies have also reported an inverse relationship between the post

partum variables and the birth intervals (Nath *et al.*, 1994; Ofosu 1989). However, efforts of cross-cultural comparison of the effects of breastfeeding and post partum amenorrhoea on fertility have been undermined due to a non-availability of appropriate data.

Distribution of the duration of LCBI was found highly related to the duration of breastfeeding and post partum amenorrhoea (not applicable for FBI) (Appendix Table 5.1). The mean duration of LCBI increased from a low value of 25.3 months among mothers who breast feed for 0-11 months to a high value of 42.8 months among those mothers who breast feed for 36 months or more. Similarly, the mean duration of LCBI increased from 31.2 months for mothers who were amenorrhoeic for 0-2 months to 34.7 months among mothers who were amenorrhoeic for 9 months or more. The relationship of the LCBI with the duration of breastfeeding and post partum amenorrhoea is also evident from the univariate proportional hazard model analysis (Table 5.1) as well as from the multivariate proportional hazard analysis (Table 5.2). In table 5.2 the symbol (-) indicates the base category for each variable for which the relative risk is 1. The relative risks for the longer duration of breastfeeding were significantly lower than the reference category 0-11 months in case of LCBI, indicating an increase in the duration of this birth interval by an increase in breastfeeding after controlling the effects of the other variables in the model. However, the duration of LCBI was statistically not different among mothers whose post partum amenorrhoea was less than 9 months. A slightly zig-zag nature of the closed birth interval may be partly due to bimodal nature of PPA, and partly due to heterogeneity in BF practices or PPA itself (Huffman *et al.*, 1987).

5.3.3.2 Birth intervals in relation to parity and age related variables

Age at return-marriage, age and parity of mother are events that determine the reproductive exposure span of a mother. The age related variables like age at return marriage and age of mother at the time of birth of the child

were all significantly related with the distribution of the duration of FBI. The mean duration of FBI (LCBI) was 50.6 (33.2) months for mothers whose age at return marriage was less than or equal to 14 years and 31.2 (33.4) months for mothers whose age at return marriage was 18 months or more. Thus, age at return marriage has an inverse relationship with the duration of FBI. It was also observed that the mean duration of FBI and LCBI increased from about 28 months for the mother's present age group 16 -24 years to about 46 months (in case of FBI) and 37 months (in case of LCBI) for the mother`s present age group 35+ years (see Figures 5.3 and 5.4). The present age and parity order of mother were found to have their significant effects on the duration of LCBI (Tables 5.1). Both the variables mentioned their significant impact on this birth interval after controlling the effects of other variables in multivariate analysis. The age at return marriage also maintained its significant influence on the duration of LCBI in the multivariate analysis (Table 5.2). However, the duration of LCBI was found not affected by the age of mother at the birth of the child (Table 5.2). This may be due to presence of multicollinearity related with the other age covariates.

5.3.3.3 Birth intervals in relation to sex, age and survival status of the child

The three child-specific variables, namely, sex of the child, age of child at the survey date, and the survival status of the child at the next event, are included to examine their effects on the last closed birth interval (LCBI). Indian society is known for its preference for male children. It is presumed that the birth of a male child influences the timing of the next birth. Further, in a study of rural Uttar Pradesh, India, a woman has been found to experienced a shorter birth interval by 9 months than the woman who had not experienced an infant death (Singh, *et al.*, 1993).

Mothers have had slightly higher values of LCBI if they had a male child than those mothers who had a female child. This may have been related to the

longer duration of breastfeeding in favour of the male infant on one side and due to high infant mortality among female children and hence an increased desire to have the next child as male on the other side. The univariate analysis also showed a significant impact of sex on the hazard function of LCBI (Table 5.1). However, the multivariate analysis, when controlled for other covariates, nullified the effect of sex on the duration of LCBI (Table 5.2). That is there is no significant difference in the duration of last closed birth interval whether the child is a male or a female.

As expected, the age of child at the survey date has a positive and significant relation with the distribution of LCBI (Appendix Table 5.1). This relationship was maintained and found statistically significant in univariate and multivariate analyses (Tables 5.1 and 5.2). However, the effect of age of child on the birth interval is expected to be mainly due to the effect of breastfeeding. This may be seen that the older the child, the longer he / she would have been breast fed, and consequently, the longer length of the respective closed birth interval.

The survival status of the child could influence the birth intervals either by reducing (in case the child is dead) or lengthening (in case the child is alive) the duration of breastfeeding at the next event. Obviously, the event of a still birth or death of a child, increased the desire of another child, which results in high coital frequency and hence shortening the length of birth intervals. This variable was found related to the distribution of the LCBI and this relationship was maintained even in the univariate and multivariate hazard model analyses (Tables 5.1 and 5.2). The mean duration of the LCBI was reduced from about 33 months, found among mothers whose child survived at the next event, to about 26 months for mothers whose child did not survive. The hazard model showed that when the child died as an infant, the adjusted risk of the next birth was much higher than for women who had not experienced death of the child (Table 5.2).

5.3.4 Birth intervals in relation to socio-economic variables

Socio-economic status of women has been found strongly related to the duration of birth intervals in the developing countries (Bhattacharya *et al.*, 1994; Singh, 1993). Seven socio-economic variables have been used in this study. There is wide variation in the duration of birth intervals by various socio-economic characteristics of the women. The education variables (EDUW and EDUH) showed an inverse and significant relationship with the distribution of FBI, whereas no relationship with the distribution of LCBI was observed (Appendix Table 5.1). The mean duration of FBI decreased with higher education of both husband and wife (Fig.5.3). A very little variation in the mean duration of LCBI was observed across the educational categories of husbands and their wives. Nevertheless, after controlling for the effects of other variables in multivariate proportional hazard model analysis, the effect of education of both husband and wife on FBI disappeared, while they have had some effects on the duration of LCBI. The relative risk ratios increased with an increase in the education of mother, thus showed a lowering impact on the duration of LCBI with a rise in the education compared to reference category illiterate. The wives in the husband's education category of MID-HIGH have also been found to have a significantly shorter duration of LCBI than others. Thus, the multivariate hazard analysis showed that even after adjusting for covariates, the risk of a shorter duration of FBI or LCBI was significantly higher among highly educated group of women. In general, education has a negative effect on the duration of first birth interval and a positive effect on the duration of last closed birth interval. This may be due the fact that marriages among educated group are now taking place at some higher ages (as seen in the previous section) where risk of conceiving a female for the first birth becomes higher whereas such females avoid early higher order births by using some contraceptive means (Khalifa, 1989 and Yadava and Jain, 1998). Singh *et al.* (1993) have also reported that after the first birth the trend was reversed with women in younger age at marriage

groups having a significantly higher risk of another child than the older mothers.

The other five household level socio-economic variables (HHTYPE, OCCHH, HOUSE, ECONHH and SOCIALHH) showed their individual effects on the duration of FBI and LCBI. Out of these, the social status and type of household were found to have some association with the distribution of the duration of both the birth intervals (Appendix Table 5.1). Mothers in the high social and economic status group were found to have higher mean values of the duration of LCBI and FBI. Mothers living in joint-agricultural-kaccha houses exhibited higher mean values of the duration of FBI and LCBI. In the univariate hazard model analysis, the status of the house and the economic status of the household were found to have significant impact on the hazard function of the LCBI (Table 5.1). However, the multivariate analysis showed insignificant effects of all the socio-economic variables on the birth intervals after controlling the effects of other explanatory variables, except the economic status of the household which showed its impact on FBI at 10% level of significance (Table 5.2).

5.3.5 Birth intervals in relation to cultural variables

The variables, caste and religion of mothers seem to have impact on the duration of FBI but not on the duration of LCBI in the study area. The mean duration of FBI and LCBI was higher (about 37 and 32 months respectively) among Hindu mothers than (about 29 and 31 months respectively) among the Muslim mothers. Though a univariate analysis shows significant impact of caste and religion on the duration of FBI (Table 5.1), the multivariate results did not show much significant difference in the risk of the duration of first birth interval according to religion (Table 5.2). The duration of LCBI was, however, found longer among Hindu mothers than among Muslims (Table 5.2). Among Hindus, the relative risk ratios of all castes were found lower than the reference caste High, showing a significantly longer duration of the

FBI for mothers of these castes than the High caste mothers. As stated earlier, it may be due to high literacy rate among the society of High castes. A significantly shorter duration of LCBI was found among mothers belonging to Business caste group as compared to high castes.

5.4 Conclusions

A pattern of heaping was observed at the multiples of 6 and 12 months in the data of the duration of birth intervals under studied. This is attributable to recall lapses due to high rate of illiteracy among respondents in eastern Uttar Pradesh and the prevalence of various social taboos and customs.

The mean length of the duration of birth intervals reported was found longer consistent with other studies in Indian subcontinent than the developed nations. Adolescent sterility, fetal loss, taboos and customs regarding temporary separation of wife and husband just after the marriage, are some of the important reasons for the longer first birth interval. Mothers usually do not report fetal loss, particularly if it occurred before the first live birth. The present age of mother, her age at the return marriage and her caste were significantly related with the duration of first birth interval. A high positive relationship of the duration of first birth interval with the present age of mother shows a decreasing pattern of first birth interval over time, which may be due to increased average age at marriage and a decreased risk of adolescent sterility.

The duration of breastfeeding and post partum amenorrhoea has had positive and significant effects on the length of last closed birth interval. Eastern Uttar Pradesh is a traditional society like many other developing countries where mothers have a combination of poor nutritional status and observance of various socio-cultural taboos during breastfeeding, which result in a decreased coital frequency and hence a longer birth interval (Nath *et al.*, 1994; Yadava and Jain, 1998). Moreover, breastfeeding continues for

some time even during the pregnancy (Singh, 1993) in Eastern Uttar Pradesh, implying a traditional pattern of prolonged breastfeeding in the society. This is one of the reasons that the effect of breastfeeding on the duration of birth interval after a certain period was found negligible. Abstinence from coitus during post partum stage, when a female is considered to be 'unclean', prevalence of joint family system, and hence shortage of dwelling room, are some of the other reasons for longer birth intervals.

A positive and inverse J-shaped relation of the duration of post partum amenorrhoea with the length of last closed birth interval shows the existence of bimodal distribution of the duration of post partum amenorrhoea. An increased duration of the post partum amenorrhoea significantly increased the duration of last closed birth interval. The present age of the mother, her parity and survival status of the child were found significantly related with the duration of last closed birth interval. A decrease in fecundability and an increased duration of breastfeeding at older ages would have increased the length of birth intervals. Breastfeeding stops suddenly after the death of the child and an increased coital frequency results due to a desire for the next child and hence it shortens the length of birth interval in case of infant died. Education, religion, and caste of mother have significant effects on the duration of birth intervals. The socio-economic variables at the household level have little and insignificant impact on the length of birth intervals.

Besides all these, it is worth mentioning that heterogeneity plays its important role in the analysis of fertility and reproduction data, particularly birth interval data. However, women's fecundability in the study population does not vary much and whatever variation we expect is expected to be explained by explanatory variables considered under the study. The unaccounted cultural factors, which are common in the population, vary by the socio-economic variables (See, *e.g.*, Bhattacharya *et al.*, 1994; Singh, 1993).

Table 5.1: Univariate analysis of LCBI and FBI - using the proportional Hazard model

Model	LCBI (n=767)				FBI (n=1060)			
	-2 LOG L with Covariates	Model χ^2	df	p	-2 LOG L with Covariates	Model χ^2	df	p
NULL	8714.830				12733.699			
FBF	8706.883	7.948	3	0.0471				
PBF	8656.200	58.631	3	0.0001				
CBF	8646.321	68.509	3	0.0001				
PPA	8706.210	8.621	3	0.0348				
PARITY	8709.989	4.841	3	0.1838	12725.322	8.378	3	0.0388
AGECH	8680.341	34.489	2	0.0001	12639.370	94.330	2	0.0001
AGEMOTH	8714.080	0.751	2	0.6871	12655.031	78.668	2	0.0001
AGEMOTC	8710.802	4.029	2	0.1334	12656.437	77.262	2	0.0001
AGERM	8711.598	3.232	3	0.3572	12712.362	21.337	3	0.0001
EDUH	8709.914	4.916	2	0.0856	12696.899	36.800	2	0.0001
EDUW	8713.772	1.058	1	0.3037	12719.127	14.573	1	0.0001
RELIGION	8707.261	7.570	4	0.1087	12683.533	50.166	4	0.0001
CASTE	8714.449	0.381	1	0.5370	12726.792	6.907	1	0.0086
HHTYPE	8713.697	1.133	2	0.5674	12729.261	4.438	2	0.1087
OCCHH	8713.903	0.927	2	0.6291	12731.182	2.518	2	0.2840
HOUSE	8706.354	8.476	2	0.0144	12731.142	2.557	2	0.2784
ECONHH	8707.482	7.348	2	0.0254	12729.474	4.225	2	0.1209
SOCIALHH	8714.106	0.725	1	0.3946	12733.628	0.071	1	0.7895
SEX	8704.714	10.116	1	0.0015				
CHALIVE	8613.507	101.324	3	0.0001				

Variables: FBF, full breast feeding; CBF, combined breast-feeding; AGEMOTH, present age of mother; AGEMOTC, age of mother at birth of child; AGERM, age of women at return marriage; PARITY, parity of mother; AGECH, age of child; CHALIVE, survival status of child; SEX, sex of child; HHTYPE, type of household; HOUSE, type of house; OCCHH, main occupation of household; ECONHH, economic status of household; SOCIALHH, social status of household; EDUH, education of husband; EDUW, education of wife; RELIGION, religion; CASTE, caste

Table 5.2: Multivariate proportional Hazard model analysis - LCBI AND FBI

		LCBI		FBI	
VARIABLE	GROUP	Risk Ratio	p	Risk Ratio	p
CBF	0-11	.	.		
	12-23	0.669	0.0002		
	24-35	0.442	0.0001		
	36+	0.275	0.0001		
PPA	0-2	.	.		
	3-5	0.981	0.8833		
	6-8	1.110	0.3952		
	9+	0.837	0.0601		
PARITY	1-2	.	.		.
	3-4	1.489	0.0004		
	5-6	1.868	0.0001		
	7+	1.740	0.0047		
AGEMOT	16-24	.	.	.	.
	25-34	0.671	0.0021	0.711	0.0001
	35+	0.471	0.0001	0.450	0.0001
AGEMOC	10-24	.	.		
	25-34	1.027	0.8064		
	35+	1.165	0.5032		
AGERM	9-14	.	.	.	.
	15-17	1.037	0.7335	1.715	0.0001
	18+	1.050	0.7244	1.834	0.0001
EDUH	ILLITERATE	.	.	.	.
	PRIMARY	1.037	0.7420	1.149	0.1320
	MID-HIGH	1.246	0.0550	0.970	0.7516
	INTER+	1.226	0.1712	1.109	0.3607
EDUW	ILLITERATE	.	.	.	.
	PRIMARY	0.667	0.0008	1.095	0.3462
	MIDDLE+	0.747	0.0417	1.156	0.1783
RELIGION	HINDU	.	.	.	.
	MUSLIM	2.972	0.0019	1.105	0.8033

Table 5.2 (Continued)

VARIABLE	GROUP	LCBI Risk Ratio	LCBI p	FBI Risk Ratio	FBI p
CASTE	HIGH	.	.	.	.
	MIDDLE	1.039	0.7821	0.627	0.0001
	BUSINESS	1.327	0.0934	0.674	0.0010
	SCH.CASTE	1.087	0.6131	0.707	0.0057
	MUSLIMS	0.340	0.0047	0.987	0.9752
HHTYPE	JOINT	.	.	.	.
	NUCLEAR	1.031	0.7398	1.094	0.2443
OCCHH	AGRICULTRE	.	.	.	.
	SERVICE	0.890	0.4344	1.202	0.1226
	DOMESTIC	0.944	0.6734	1.118	0.3096
HOUSE	KACCHA	.	.	.	.
	PUKKA	0.975	0.8192	0.939	0.5036
	MIXED	1.069	0.5818	0.931	0.4720
ECONHH	LOW	.	.	.	.
	MIDDLE	0.975	0.7869	0.877	0.1104
	HIGH	0.858	0.2152	0.848	0.0913
SOCIALHH	LOW	.	.	.	.
	MIDDLE	1.014	0.8883	0.918	0.3241
	HIGH	0.869	0.3909	0.960	0.7466
SEX	MALE	.	.		
	FEMALE	1.125	0.1331		
CHALIVE	ALIVE	.	.		
	NOT ALIVE	2.934	0.0001		
AGECH	0-11	.	.		
	12-23	0.111	0.0048		
	24-35	0.101	0.0024		
	36 +	0.051	0.0001		

	LCBI	FBI
n	767	1060
-2LOG L (NULL)	8714.830	12733.699
-2LOG L (Model)	8445.485	12498.481
Model χ^2	258.468	235.218
df	38	23
p	0.0001	0.0001

.(dot) indicates the base category.

Appendix Table 5.1: Two-way analysis of LCBI and FBI with other variables

	LCBI (N=767)			FBI (N=1060)		
VARIABLE	df	χ^2	p	df	χ^2	p
FBF	9	10.892	0.283			
CBF	9	135.275	0.001			
PPA	9	45.841	0.001			
PARITY	9	8.678	0.468			
AGECH	9	111.068	0.001			
AGEMOTH	6	37.404	0.001	6	89.723	0.001
AGEMOTC	6	7.354	0.289	6	67.238	0.001
AGERM	6	10.955	0.090	6	121.080	0.001
EDUH	9	5.527	0.786	9	29.509	0.001
EDUW	6	5.682	0.460	6	48.424	0.001
RELIGION	3	0.702	0.873	3	15.611	0.001
CASTE	12	8.669	0.731	12	89.313	0.001
HHTYPE	3	0.802	0.849	3	17.558	0.001
OCCHH	6	10.444	0.107	6	9.686	0.138
HOUSE	6	7.844	0.250	6	6.596	0.360
ECONHH	6	6.950	0.326	6	7.200	0.303
SOCIALHH	6	15.029	0.020	6	23.489	0.001
SEX	3	6.150	0.105			
CHALIVE	3	25.523	0.001			

Figure 5.1: Percentage Distribution of Duration of First Birth Interval

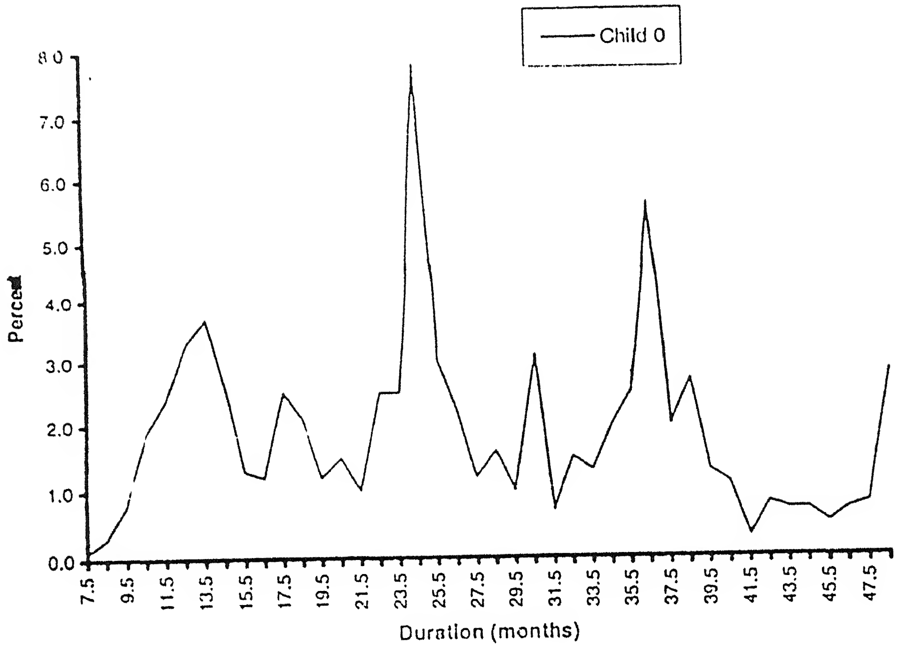


Figure 5.2: Percentage Distribution of Duration of Closed Birth Interval

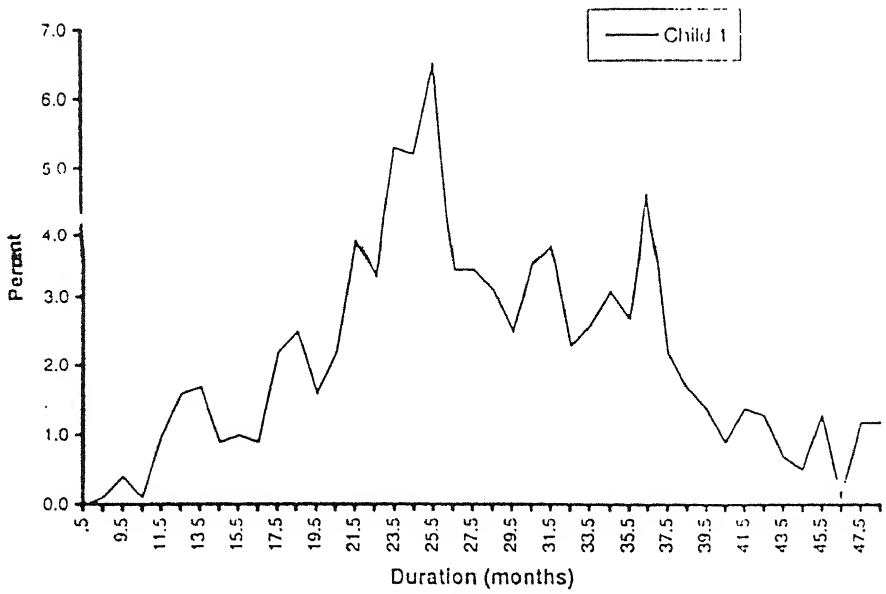


Figure 5.3: Mean Duration of First Birth Interval by Characteristics of Women

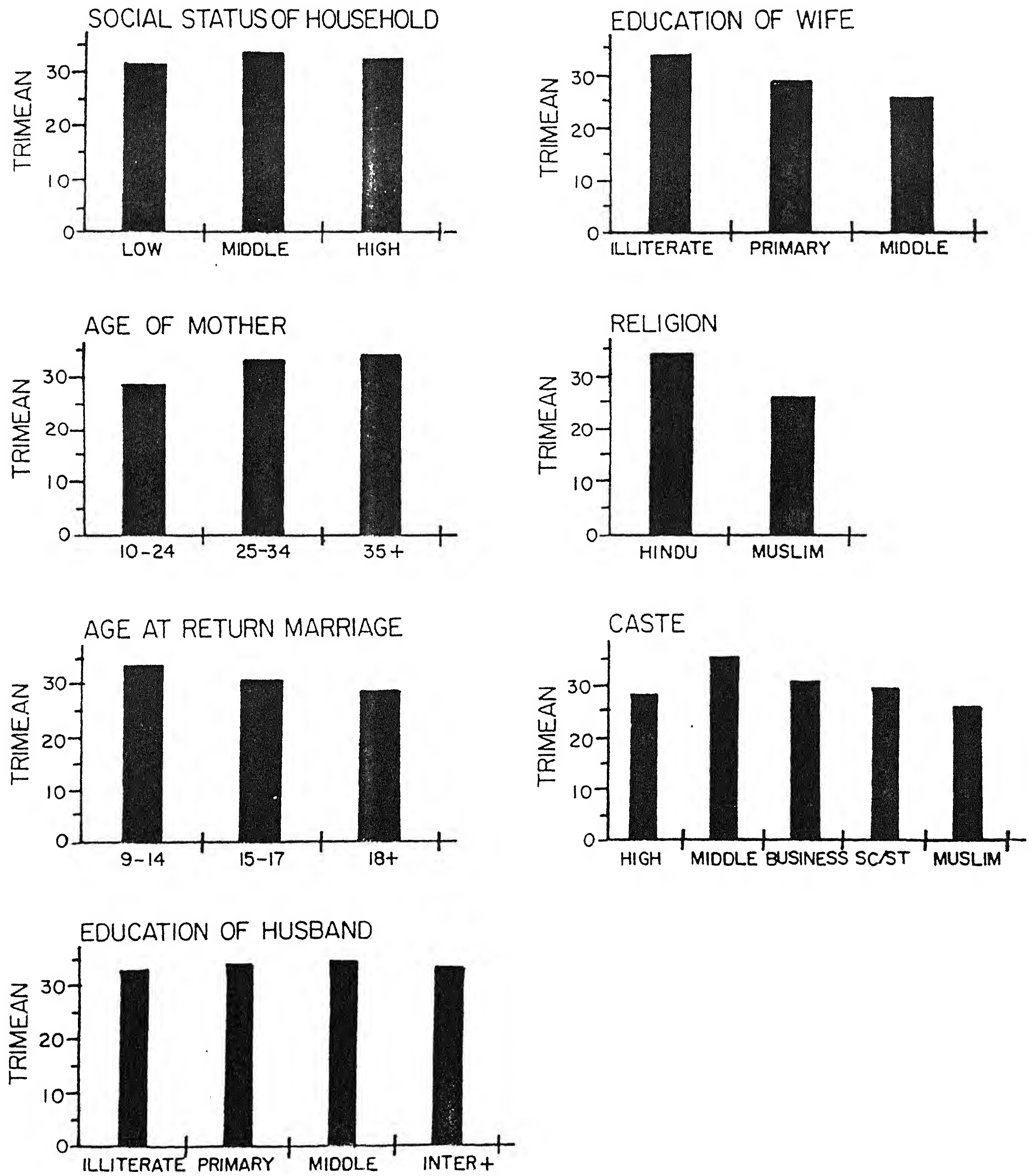
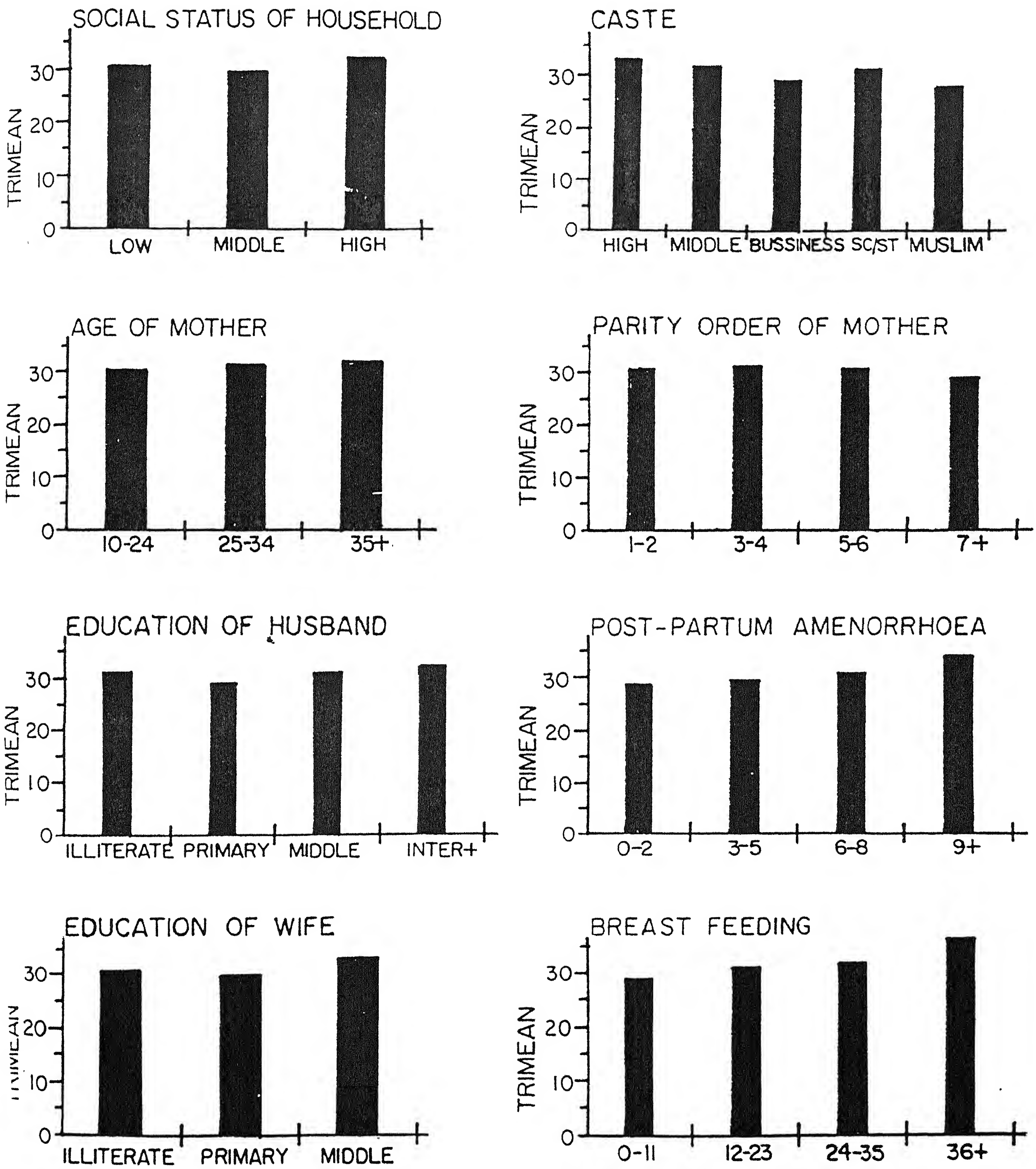


Figure 5.4: Mean Duration of Last Closed Birth Interval by Characteristics of Women



CHAPTER - VI

CHAPTER-VI

SOME INVESTIGATIONS UNDER STABLE POPULATION THEORY IN PRESENCE OF MIGRATION

6.1 Introduction

A closed population (closed to migration) of one sex (female sex) under unchanging pattern of fertility and mortality schedules over a long period of time approaches to a stable population with a fixed structure and its size increases with a constant growth rate, say, r. In case of zero growth (*i.e.*, when r=0) the population size becomes fixed and population reduces to the state of stationary or replacement level. Demographic models under stability conditions are well recognised among social scientists and policy makers because of its suitability and simplicity in mathematical treatment as well as its applications. Several efforts have been made to predict population size at some future time for varying path of reduction in fertility schedule under stability conditions (Cerone, 1996; Frauenthal, 1975; Keyfitz, 1971; Mitra, 1976; Singh *et al.*, 1981b; Yadava, 1985; Yadava *et al.*, 1989, 1996). However, an accuracy of projection lies not only on the techniques used but also on how far realistic assumption are made about the demographic parameters. Population projection under stability conditions is usually done either for a short period or for a long period when population restabilises after demographic transition or to the level of replacement.

It is, however, difficult to keep a society closed to migration for a long-time because movement in a society is inevitable for its development. In any developing country where inequality exists in respect of socio-economic, demographic, cultural and political variables, migration is bound to occur. Keyfitz's (1975) works may be considered one of the starting points of any in-depth study of the effects of migration on demographic parameters under

stability conditions. He has shown that if there exists a continued stream of out-migration /emigration of a certain proportion of population at a particular age over a long period of time then population eventually re-stabilised under a new set-up.

A number of countries use transmigration programme to reduce the population pressure at some of its particular region. For example, some inhabitants of Java go to Sumatra every year under an official transmigration programme and it has been a policy of the government for two thirds of the century. Under such a programme the amount of relief provided to Java however, depends on the age and volume of the migrants at the time of migration.

The objective of this chapter is to study the impact of emigration/out-migration on various demographic measures. This chapter is divided into two sections. In the first section, the impact of emigration is looked on the birth trajectory and hence on the population size while section second deals with the derivation of some demographic measures viz. the proportion of the cohort that emigrates and dies at the destination, expectation of life, net reproduction rates, average age, etc. in the presence of migration. The proposed expressions are also illustrated with some reasonable values of the demographic parameters.

For simplicity, all the formulae have been discussed with one sex (female population).

The male population can be obtained as

$$\text{Male population} = \text{Female population} * \text{Sex ratio at birth} * \frac{\textit{Life}\ \text{expectancy}\ \textit{of male}}{\textit{Life}\ \text{expectancy}\ \textit{of female}}$$

6.2 Effect of emigration on birth trajectory

Let E(x) persons of age x migrate year after year. Further, considering only two years say (t and t+1), (t+1, t+2), (t+2, t+3) so on. Let E(x) individuals leave in year '0'. If t is large and that the initial population is stable, then the effective rate of increase (ERI) at time t is (see Keyfitz, 1975).

$$\frac{Pe^{r(t+1)} - E(x)\,V(x)\,\frac{e^{rt}}{bK} - Pe^{rt}}{Pe^{rt}} = e^{r} - \frac{E(x)\,V(x)}{PbK} - 1 \qquad \text{.........} (6.1)$$

where

P : initial base line population,

b : birth rate,

K : mean age of child bearing in stable populations,

V(x) : Reproductive value of females at age x.

If the base line population P is stable, then there are $Pbe^{-rx}\,l(x)$ persons in the year 0 of age x where Pb = Bo, number of births. Suppose $f = \frac{E(x)}{P}$ at age x, then $E(x) = fPbe^{-rx}\,l(x)$ and putting $e^{r}-1 \approx r$. ERI at time t is approximately

$$r - fe^{-rx}\,l(x)\,\frac{V(x)}{K} \qquad \text{.........} (6.2)$$

The same calculations can be done for any pair of years, and hence (6.2) gives the effect on the value of r by a fraction f of individual aged x leaving year after year. It shows that r to be reduced by

$$fe^{-rx}\,\frac{l(x)\,V(x)}{K}$$

Thus, E(x) persons who leave in year zero lower the births at time t by $E(x)\,\frac{V(x)\,e^{rt}}{K}$, those who leave in year 1 lower the births at time t by $E(x)\,V(x)\,\frac{e^{r(t-1)}}{K}$, etc. Therefore, total lowering is

$$E(x)\,V(x)\,(e^{rt} + e^{r(t-1)} + \ldots + e^{r})/K$$

$$= E(x)\,V(x)\,e^{rt}\,(1 + e^{-r} + e^{-2r} + \ldots + e^{-(t-1)r})/K$$

$$= \frac{E(x)\,V(x)\,(e^{rt}-1)}{(1-e^{-r})K} \cong \frac{E(x)\,V(x)\,e^{rt}}{r''K} \qquad \text{......... (6.3)}$$

where $r'' = 1 - e^{-r}$.

The approximate equality holds good for large t and E(x) emigrants moving out uniformly throughout the year. This is an effect on population at time t by the emigration of E(x) persons aged x year after year starting at time zero. Therefore, total reduction in births by E(x) persons during (0,t) at time t is

$$= \frac{E(x)\,V(x)\,e^{rt}}{r''K}$$

and thus the total births lowered by persons of all age groups is

$$\int_0^w \frac{E(x)\,V(x)\,e^{rt}\,dx}{r''K} \qquad \text{........(6.4)}$$

where

$$V(x) = \frac{1}{e^{-rx}\,p(x)} \int_0^\beta e^{-ra}\,m(a,t)\,p(a)\,da \qquad \text{.........(6.5)}$$

If $m(a,t) = e^{-ra}\,m(a)$, then new reproductive value is

$$V^*(x) = \frac{1}{e^{-r^*x}\,p(x)} \int_0^\beta e^{-2ra}\,m(a)\,p(a)\,da$$

Now, $\displaystyle\int_0^w E(x)\,\frac{V^*(x)\,e^{rt}}{r''K}\,dx$

$$= \int_0^w f\,\frac{Pb\,e^{-rx}\,e^{rt}}{r''K}\left(\int_0^\beta \frac{1}{e^{-r^*x}}\,.e^{-2ra}\,p(a)\,m(a)\,da\right)dx$$

$$= f\,\frac{Pb\,e^{rt}}{r''K}\int_0^w e^{-(r-r^*)x}\int_x^\beta e^{-2ra}\,p(a)\,m(a)\,da\,dx$$

$$= f\,\frac{Pb\,e^{rt}}{r''K}\int_0^w e^{-(r-r^*)x}\,\lambda(x)\,dx \qquad \text{........(6.6)}$$

where

$$\lambda(x) = \int_x^\beta e^{-2ra}\,p(a)\,m(a)\,da \qquad \text{.........(6.7)}$$

On putting $f\,\dfrac{Pb\,e^{rt}}{r''K} = \epsilon(t)$, we have from (6.6)

$$\in(t)\int_0^{\beta} e^{-(r-r^*)x}\,\lambda(x)\,dx$$

$$= \in(t)\left\{\left.\frac{-e^{(r-r^*)x}\lambda(x)}{(r-r^*)}\right|_0^{w} - \frac{1}{(r-r^*)}\int_0^{w} e^{-(r-r^*)x}\,e^{-2rx}\,p(x)\,m(x)\,d(x)\right\} \quad \ldots\ldots(6.8)$$

$$= \in(t)\left\{\frac{\lambda(0)}{(r-r^*)} - \frac{1}{(r-r^*)}\int_{\alpha}^{\beta} e^{-(3r-r^*)x}\,p(x)\,m(x)\,d(x)\right\} \quad (\ \lambda(w)=0)$$

Since outside the range α and β, the m(x) is zero.

It should be noted here that the integral $\int_{\alpha}^{\beta} e^{-2rx}\,p(x)\,m(x)\,dx$ is very difficult to evaluate unless some additional form of the net maternity function is known. Mitra (1976) has assumed it as normally distributed and according to him

$$\int_0^{\beta} e^{-2rx}\,p(x)\,m(x)\,dx = \int_0^{\infty} e^{-2rx}\,p(x)\,m(x)\,dx = \frac{e^{r^2\sigma^2}}{R_0} \quad \ldots\ldots\ldots(6.9)$$

where R_0 is the net reproduction rate and σ^2 is the variance of the maternity function. On putting from (6.9) into (6.8) we get

$$\in(t)\left\{\frac{\lambda(0)}{(r-r^*)} - \frac{e^{r'^2\sigma^2}}{R_0(r-r^*)}\right\} = \frac{\in(t)}{(r-r^*)}\left(\lambda(0) - \frac{e^{r'^2\sigma^2}}{R_0}\right) \quad \ldots\ldots\ldots(6.10)$$

where

$$r' = \left(\frac{3r-r^*}{2}\right)$$

Now from (6.9), λ(0) can be written as

$$\lambda(0) = \int_0^{\beta} e^{-2ra}\,p(a)\,m(a)\,da\,dx = \int_0^{\beta} e^{-2ra}\,p(x)\,m(x)\,dx = \frac{e^{r^2\sigma^2}}{R_0} \quad \ldots\ldots\ (6.11)$$

From (6.10) and (6.11), we have

$$\frac{\in(t)}{(r-r^*)R_0}\left(e^{r^2\sigma^2} - e^{r'^2\sigma^2}\right) \quad \ldots\ldots\ldots(6.12)$$

Thus, total reduction in birth trajectory is

$$B^*(t) = f\,\frac{Pb\,e^{rt}}{r''K(r-r^*)R_0}\left(e^{r^2\sigma^2} - e^{r'^2\sigma^2}\right) \qquad \text{.........(6.13)}$$

Therefore, the effective birth trajectory in the presence of emigration is given by

$$B_e(t) = B(t) - B^*(t)$$

$B_e(t)$ depends on the difference of $B(t)$ and $B^*(t)$. Since we have derived expression for $B^*(t)$ during $(0,t)$ for $t \le \alpha$, therefore $B(t)$, the birth trajectory in absence of migration should also be taken for $t \le \alpha$ to illustrate the expressions. However, the amount of effective birth trajectory is valid and may provide better estimate of population size if t is sufficiently large.

Now putting the values of $B(t)$ and $B^*(t)$ for $t \le \alpha$, we have

$$B_e(t) = b\,e^{r^2\sigma^2}\,\frac{e^{rt}}{R_0} - f\,\frac{Pb}{r''K(r-r^*)R_0}\left(e^{r^2\sigma^2} - e^{r'^2\sigma^2}\right)e^{rt}$$

$$= \left\{\left(1 - f\,\frac{P}{r''K(r-r^*)}\right)e^{r^2\sigma^2} + f\,\frac{P}{r''K(r-r^*)}\,e^{r'^2\sigma^2}\right\}\frac{b}{R_0}\,e^{rt}$$

$$= A\,\frac{b}{R_0}\,e^{rt} \qquad \text{for } t \le \alpha \qquad \text{.........(6.14)}$$

where

$$A = \left\{\left(1 - f\,\frac{P}{r''K(r-r^*)}\right)e^{r^2\sigma^2} + f\,\frac{P}{r''K(r-r^*)}\,e^{r'^2\sigma^2}\right\}$$

Following Yadava (1985), once the birth trajectory is obtained the population size at any time t ($t \le \alpha$) can be obtained in the following way. Total population at any time t is the sum of (a) the survivors of births in $(0,t)$ upto time t and, (b) the survivors of the initial population upto time t. Now following the above birth trajectory given by (6.14) the total number of births at time y, $y < t \le \alpha$ is $\frac{b}{R_0}Ae^{ry}$ and the probability that they will survive upto time t is $p(t-y)$. Thus the total survivors upto time t of births in $(0,t)$ are

$$\int_0^t \frac{A}{R_0} bp(t-y)\, e^{ry}\, dy \qquad \text{.........(6.15)}$$

On putting t-y = z, equation (6.15) becomes

$$A\frac{b}{R_0} e^{rt} \int_0^t e^{-rz} p(z)\, dz \qquad \text{.........(6.16)}$$

Now the population at age y in the base line population is $(1\text{-}f)be^{-ry}$ p(y) and the probability that they will survive upto time t is p(y+t)/p(y) and hence the total survivors of the initial population at time t are

$$\int_0^w (1-f)be^{-ry}\, p(y)\, \frac{p(y+t)}{p(y)}\, dy$$

i.e. $$(1-f) \int_0^w be^{-ry}\, p(y+t)\, dy \qquad \text{.........(6.17)}$$

where w is the highest age of life.

On putting y+t = z in (6.17) we get

$$(1-f)\, be^{rt} \int_t^w e^{-rz} p(z)\, dz \qquad \text{.........(6.18)}$$

Thus the population size at time t ($t \le \alpha$) can be obtained by adding expressions (6.16) and (6.18) *i.e.*,

$$A\frac{b}{R_0} e^{rt} \int_0^t e^{-rz} p(z)\, dz + (1-f)\, be^{rt} \int_t^w e^{-rz} p(z)\, dz$$

$$= \frac{A}{R_0} e^{rt} \int_0^t be^{-rz} p(z)\, dz + (1-f)\, be^{rt} \int_t^w e^{-rz} p(z)\, dz$$

$$= \frac{A}{R_0} e^{rt}\, \overline{A}_t + (1-f)\, e^{rt}\, (1-\overline{A}_{(t)})$$

(where $\overline{A}_{(t)} = \int_0^t be^{-rz} p(z)\, dz$)

$$= \left\{(1-f) + \left(\frac{A}{R_0} - (1-f)\right)\overline{A}_{(t)}\right\} e^{rt} \qquad \text{.........(6.19)}$$

If $f = 0$, then (6.19) reduces to

$$\left[1 - \left\{1 - \frac{e^{r^2\sigma^2}}{R_0}\right\}\overline{A}_{(t)}\right]e^{rt} . \qquad \text{.........(6.20)}$$

an expression already deloped by Yadava (1985) in the absence of migration.

6.3 Effect of emigration on some other Demographic measures

The purpose of this section is to derive some analytical expressions to study the effect of emigration on several other demographic parameters. The effect of emigration has not been only seen on countries of origin and destination in terms of lowering the fertility and the rate of growth of concerned populations but also in terms of other demographic aspects. Such studies however, may encourage the planners to initiate necessary actions for improving the coverage and quality of emigration statistics. Noting the similarity between migration and death as both forces are responsible for population decline and to that extent they can be analysed in the same manner. Therefore, like the force of mortality $\mu(x)$ which is defined as a measure of the pattern of depletion in the population by death specific for all ages, a similar measure for emigration specific for age, call it the force of outward mobility (Mitra, 1988) is denoted by $0(x)$.

Now the relationship between $\mu(x)$ and the life table survivorship function $p(x)$ is given by (see Coale, 1972)

$$-\frac{1}{p(x)}\frac{dp(x)}{dx} = \mu(x) \qquad \text{.........(6.21)}$$

Therefore, in the presence of emigration an expression parallel to (6.21) can be written as

$$-\frac{1}{p^*(x)}\frac{dp^*(x)}{dx} = \mu(x) + 0(x) \qquad \text{.........(6.22)}$$

where $p^*(x)$ is the proportion of the birth cohort alive at age x in the country of birth (origin). Assuming a negligible return migration, we have from (6.21) and (6.22) as

$$p(x) = e^{-\int_0^x \mu(y)\,dy} \qquad \text{.........(6.23)}$$

and

$$p^*(x) = e^{-\int_0^x \{\mu(y)+0(y)\}dy} \qquad \text{.........(6.24)}$$

or

$$p^*(x) = p(x)\, e^{-\int_0^x 0(y)dy} \qquad \text{.........(6.25)}$$

Thus the effect of emigration on a cohort of babies as they grow old in the country of birth can be studied.

Mitra (1988) considered a constant proportion of individuals emigrate at all ages and has worked out expressions for some demographic measures. However, the rate of emigration may vary with ages which is maximum among labour force and minimum among children and aged population. Under such an assumption, the form of force of outword mobility is taken as :

$$0(y) = \begin{cases} 0 & \text{if } y < \alpha \\ f & \text{if } \alpha \le y \le \beta \\ 0 & \text{if } y > \beta \end{cases} \qquad \text{.........(6.26)}$$

where α and β are the lower and upper limits of the reproductive period. Usually $\alpha = 15$ and $\beta = 45$ years.

On putting from expression (6.26) into (6.25), we get

$$p^*(x) = \begin{cases} p(x) & \text{if } x \le \alpha \\ p(x)\, e^{-fx} & \text{if } \alpha < x \le \beta \\ p(x) & \text{if } x > \beta \end{cases} \qquad \text{.........(6.27)}$$

The expression (6.27) gives an effect of emigration on p(x) function.

6.3.1 Measures based on Mortality and Emigration

Supposing w as the highest age of life, we have for the expectation of life as:

$$e^*(0) = \int_0^w p^*(x)\, d(x) = \int_0^\alpha p(x)\, dx + \int_\alpha^\beta p(x)\, e^{-fx}\, dx + \int_\beta^w p(x)\, dx$$

Taking $e^{-fx} \cong 1 - fx$ for a small value of f

$$e^*(0) = \int_0^w p(x)\, dx - f \int_\alpha^\beta x\, p(x)\, dx$$

Usually it is found that p(x) is linearly distributed over the range of x (Coale, 1972) and if it is so, then

$$\int_\alpha^\beta p(x)\, dx \cong \left(\frac{\beta - \alpha}{w - 0}\right) e(0) \qquad \text{........ (a)}$$

where w is the maximum limit of x. Numerically, if p(x) decline linearly as p(x) $\cong$ (1–cx) where c is constant proportion, then

$$\int_\alpha^\beta (1 - cx)\, dx = (\beta - \alpha) - c\left(\frac{\beta^2 - \alpha^2}{2}\right) \qquad \text{.........(b)}$$

we take α = 15, β = 45, c = 0.010 and w = 90, e(0) = 60 then

$$\left(\frac{\beta - \alpha}{w}\right) e(0) = 20$$

and

$$(\beta - \alpha) - c\left(\frac{\beta^2 - \alpha^2}{2}\right) = 21$$

So (a) and (b) are approximately equal under the linear decline in p(x).

$$e^*(0) \cong e(0) - f\, e(0)\, \bar{a}\left(\frac{\beta - \alpha}{w}\right)$$

$$= e(0)\left[1 - f\left(\frac{\beta - \alpha}{w}\right)\bar{a}\right] \qquad \text{........ (6.28)}$$

where $\bar{a} = \dfrac{\int_0^w x\, p(x)\, dx}{\int_0^w p(x)\, dx}$ is the average age of the stationary population.

Expression (6.28) shows that $e^*(0) < e(0)$.

Again

$$\int_0^w x\, p^*(x)\, d(x) = \int_0^\alpha x\, p(x)\, dx + \int_\alpha^\beta x(1 - fx)\, p(x)\, dx + \int_\beta^w x\, p(x)\, dx$$

$$\cong \int_0^w x\, p(x)\, d(x) - f \int_\alpha^\beta x^2\, p(x)\, dx$$

$$\cong \bar{a}e(0) - f(\bar{a}^2 + \sigma^2)\, e(0) \left(\frac{\beta - \alpha}{w}\right)$$

$$\cong e(0) \left\{\bar{a} - f(\bar{a}^2 + \sigma^2) \left(\frac{\beta - \alpha}{w}\right)\right\} \qquad \text{.........(6.29)}$$

Therefore the expression parallel to $\bar{a}$ is

$$\bar{a}^* = \frac{\int_\alpha^\beta x\, p(x)\, dx}{\int_\alpha^\beta p(x)\, dx}$$

or

$$\bar{a}^* = \frac{\left\{\bar{a} - f(\bar{a}^2 + \sigma^2) \left(\frac{\beta-\alpha}{w}\right)\right\}}{\left\{1 - f\left(\frac{\beta-\alpha}{w}\right)\bar{a}\right\}} \qquad \text{.........(6.30)}$$

or

$$\bar{a}^* = \left\{\bar{a} - f(\bar{a}^2 + \sigma^2) \left(\frac{\beta - \alpha}{w}\right)\right\} \left\{1 - f\left(\frac{\beta - \alpha}{w}\right)\bar{a}\right\}^{-1} \qquad \text{.........(6.31)}$$

for small f, $\left|f\left(\frac{\beta-\alpha}{w}\right)\bar{a}\right| < 1$ so expanding $\left\{1 - f\left(\frac{\beta-\alpha}{w}\right)\bar{a}\right\}^{-1}$ by binomial theorem.

We have

$$\left\{1 - f\left(\frac{\beta - \alpha}{w}\right)\bar{a}\right\}^{-1}$$

$$= 1 + f\left(\frac{\beta - \alpha}{w}\right)\bar{a} + \left\{f\left(\frac{\beta - \alpha}{w}\right)\bar{a}\right\}^2 + \left\{f\left(\frac{\beta - \alpha}{w}\right)\bar{a}\right\}^3 + \ldots \qquad \text{.........(6.32)}$$

Neglecting terms having power more than one, expression (6.32) takes the form

$$\left\{1 - f\left(\frac{\beta - \alpha}{w}\right)\bar{a}\right\}^{-1} = 1 + f\left(\frac{\beta - \alpha}{w}\right)\bar{a} \qquad \text{........ (6.33)}$$

and hence (6.33) becomes

$$\bar{a}^* = \left\{\bar{a} - f(\bar{a}^2 + \sigma^2) \left(\frac{\beta - \alpha}{w}\right)\right\} \left\{1 + f\left(\frac{\beta - \alpha}{w}\right)\bar{a}\right\} \qquad \text{.........(6.34)}$$

Showing that $\bar{a}^* < \bar{a}$ in the stationary population. It is informative that more accurate values of these parameters can be obtained by first computing $p^*(x)$ from (6.28) and then computing $e^*(0)$ and $\bar{a}^*$ from their respective standard

formulae. For small value of f, however, (6.28) and (6.34) may be reasonable approximations.

The proportion of the cohort that emigrates and dies abroad is another interesting index which can be derived from $p^*(x)$ and $0(x)$ as

$$p(e) = \int_0^w p^*(x)\, 0(x)\, dx$$

$$= f \int_\alpha^\beta p(x)\,(1-fx)\, dx$$

$$= \left(\frac{\beta-\alpha}{w}\right) f\, c(0)\,(1-f\bar{a}) \qquad \text{.........(6.35)}$$

The complement $1 - \left(\frac{\beta-\alpha}{w}\right) fc(0)\,(1-f\bar{a})$ is the proportion that stays and dies in the country of birth is another interesting index. The average age of emigrants at the time of emigration can be obtained as

$$\bar{x}(e) = \frac{\int_0^w x\, p^*(x)\, 0(x)\, dx}{\int_0^w p^*(x)\, 0(x)\, dx}$$

$$= \frac{\int_\alpha^\beta x\, p(x)\, e^{-fx}\, dx}{\int_\alpha^\beta p(x)\, e^{-fx}\, dx}$$

$$\bar{x}(e) \cong \{\bar{a} - f(\sigma^2 + \bar{a}^2)\}\,\{1 + f\bar{a}\} \qquad \text{.........(6.36)}$$

$\bar{x}(e)$ seems slightly lower than $\bar{a}^*$, a result similar to Mitra (1988). The only difference may be due to age specific emigration rates. On other hand, average age of emigrants is lower than resident population.

6.3.2 Measures based on Fertility, Mortality and Emigration

Now including fertility component of the demography, the net reproduction rate, in presence of emigration and under changing fertility schedule can be written as

$$R_0^* = \int_\alpha^\beta p^*(x)\, m^*(x)\, dx$$

$$= \int_{\alpha}^{\beta} p(x)\, e^{-fx}\, m^*(x)\, dx$$

If $m^*(x)$ also changes as $m(x)e^{-rx}$ where r is the rate of natural increase in the population, then

$$R_0^* = \int_{\alpha}^{\beta} p(x)\, e^{-fx}\, m(x)\, e^{-rx}\, dx$$

$$= \int_{\alpha}^{\beta} e^{-(f+r)x}\, p(x)\, m(x)\, dx$$

$$\cong \int_{\alpha}^{\beta} (1-(f+r)x)\, p(x)\, m(x)\, dx \qquad \text{.........(6.37)}$$

for small value of (r+f)

$$= R_0\,[1 - (f+r)\mu]$$

where $\mu = \dfrac{\int_{\alpha}^{\beta} x\, p(x)\, m(x)\, dx}{\int_{\alpha}^{\beta} p(x)\, m(x)\, dx}$ is the average age of motherhood and a measure parallel to this is

$$\mu^* = \int_{\alpha}^{\beta} x\, p^*(x)\, m^*(x)\, dx / R_0^* \qquad \text{.........(6.38)}$$

Now

$$\int_{\alpha}^{\beta} x\, p(x)\, e^{-fx}\, e^{-rx}\, m(x)\, dx$$

$$= \int_{\alpha}^{\beta} x\, e^{-x(f+r)}\, m(x)\, p(x)\, dx$$

$$\cong \int_{\alpha}^{\beta} x\,(1 - x(f+r))\, m(x)\, p(x)\, dx$$

$$= R_0\, \mu - (f+r)[\sigma^2 + R_0^2 \mu^2]$$

Therefore, $\mu^* = \dfrac{\mu - (f+r)R_0\mu^2 - (f+r)\sigma^2}{1-(f+r)\mu}$

$$\cong \mu - (f+r)R_0\mu^2 - (f+r)\sigma^2 - (f+r)\mu^2 + (f+r)^2 R_0 \mu^3 \,|\, + (f+r)^2\, \mu\sigma^2$$

$$\cong \mu - (f + r)\sigma^2$$

$$\mu^* = \mu - (f + r)\sigma^2 \qquad \text{.........(6.39)}$$

where σ^2 is the variance of the distribution of net maternity function.

The values of these parameters can be obtained directly for any given values of f and r. However, the expressions showing relationship between these and their counterparts in closed population have a number of implications. The formulae derived not only give comparison between these two sets but also provide quick estimates of the parameters for alternative values of 'f' without repeating all the steps. These results however, are valid for small values of 'f' for which the approximations hold reasonably good. Almost all the demographic measures derived under the presence of emigration give lower estimates in the country of birth.

6.4 Illustration

An illustration of the demographic measures proposed in this paper need the estimate of several parameters to obtain their values. The values of basic parameters required are expectation of life at birth e(0) of females; rate of natural increase r; mean age of child bearing in stable population K; average age of the stationary population $\bar{a}$; net reproduction rate R_0; age variance of the maternity function σ^2. The values of several parameters are taken from the Regional Model Life Table (Coale and Demeny, 1966; South level 13).

Some of the estimates of the parameters are taken from the data obtained from a sample survey entitled "A study of relationships among breastfeeding, post partum amenorrhoea and birth intervals in rural areas of Eastern Uttar Pradesh", sponsored by the Indian Council of Social Science Research, New Delhi conducted in 1997-98. To illustrate the derived formulae in this paper, numerical values of the parameters e(0), r, k, $\bar{a}$, μ, R0 and σ2 are taken as 50, 0.026, 28.190, 34.940, 28.646, 2.318 and 55.905 respectively.

The formula derived in the first section can be utilised to project population of any country at time t ($t \leq \alpha$) in the presence of emigration. For example, assuming growth rate $r^* = 0.010$ (as desired by Indian Population Policy Maker) and emigration rate 0.003, the population size after 15 years becomes nearly 1.1588 times the initial population whereas in closed population that is without emigration, the population size becomes 1.1593 times the initial population. Table 6.1 shows the size for different values of t ($t \leq \alpha$) assuming different rates of emigration (f).

Table 6.1: Population size for different values of t (t≤α) and emigration rates (f)

Time t (in years)	Population size*			
	r = 0.026		r^* = 0.010	
	r = 0.00	f = 0.003	f = 0.006	f = 0.010
5	1.0416	1.0394	1.0372	1.0343
10	1.0959	1.0945	1.0931	1.0913
15	1.1593	1.1588	1.1583	1.1577

*Taking initial population to be one

However, the first section gives effect of emigration on population size but its effect on other demographic measures cannot be ignored. Table 6.2 gives the values of several other demographic measures. For example, $e^*(0)$ = 48.03 for f = 0.003. The proportion of emigrants that die abroad (p(e)) was found to be 0.0504, 0.0889 and 0.1220 corresponding to emigration rates 0.003, 0.006 and 0.010 respectively. This indicates that as emigration increases, this index also increases. The average age of emigrants was found to be lower than resident population, a consistent result found by Mitra (1988). The difference, if any, may be due to age specific emigration rates taken differently in two methodologies.

Table 6.2: Values of some demographic measures under emigration

Demographic Measures	Emigration rate		
	f = 0.003	f = 0.006	f = 0.010
$E^*(0)$	48.0346	46.0693	43.4487
$\bar{a}^*$	34.8200	34.5816	34.0925
p(e)	0.0504	0.0889	0.1220
$\bar{x}(e)$	34.3708	32.9986	29.9200

Assuming e(0) = 50 years, $\bar{a}$ = 34.94 years, w = 80 years, α = 15 years and β = 45 years

CHAPTER - VII

CHAPTER-VII

SOME POPULATION GROWTH MODELS UNDER STABILITY CONDITIONS

7.1 Introduction

A number of authors (Frauenthal, 1975; Keyfitz, 1971; Mitra,1976; Singh *et al.*,1981; Yadava,1985; Yadava *et al.*,1989) have made efforts to obtain the size of population under varying path of reduction in fertility schedule, m(x) (say). For example, Frauenthal (1975) suggested an abrupt shift in fertility schedule m(x,t) as m(x,t) = ρ m(x) and then the birth trajectory B(t) (say) was ρbe^{rt} for $0 < t \leq \alpha$, where α is the lower limit of the reproductive period and ρ is a positive constant such that $0<\rho<1$. Further, Mitra (1976) suggested an age dependent abrupt change in fertility schedule as $m(x,t) = e^{-rx}m(x)$ and then birth trajectory comes out to be $B(t) = be^{-rt}\int_0^\infty e^{-2rx}p(x)m(x)dx$ for $t \leq \alpha$. Corresponding to these birth trajectories, a number of formulae have been derived to estimate the size of population at any time *t* for $t \leq \alpha$ (Singh *et al.*, 1989; Yadava, 1985).

Singh (1992) derived some formulae to find out the size of population for different values of t, say for $0 < t \leq \alpha$ and $\alpha < t \leq 2\alpha$, under an abrupt change in fertility schedule $m(x,t) = e^{-rx}m(x)$. As seen above the birth trajectories under such a schedule in fertility reduction contain integrals which are difficult to evaluate unless some functional form of maternity function p(x)m(x) is assumed. Singh has worked out some very crude approximations of these integrals putting $\int_t^\infty e^{-rx}p(x)m(x)dx \cong \frac{\beta - t}{\beta - \alpha}$ and $\int_\alpha^t e^{-rx}p(x)m(x)dx \cong \frac{t-\alpha}{t-\alpha}$, etc, where β is the upper limit of the reproductive period. These approximations, however, hold good if integrands are linearly

distributed but integrals like $\int e^{-rx}p(x)m(x)dx$ contain integrands which are multiple of three factors e^{-rx}, m(x) and p(x) having distribution of different natures. Further, an abrupt change in m(x,t) is unrealistic because voluntary implication of sterilisation may be disruptive for the concerned society (Keyfitz, 1975 and Mitra, 1976).

Keyfitz (1975) has derived an expression to find out the population size at any time t under a less drastic change in fertility schedule *i.e.* when m(x) is replaced by $m(x)\,\frac{R_0^*}{R_0}$, where R_0 and R_0^* are the existing and desired net reproduction rates respectively, such that $1 < R_0^* < R_0$, then the size of the stable population at any time t is given as :

$$I = \frac{1}{KB_0^*}\int_0^{\beta} 1(a)v^*(a)da\,e^{r^*t} \qquad \text{.........(7.1)}$$

times the initial population.

where 1(a) is age distribution at time t=0, K is the mean age of child bearing in the resulting stable population, r^* is the growth rate in the new schedule of fertility, and

$$B_0^* = \frac{1}{\int_0^{w} e^{-r^*a}p(a)da}$$

where w is the highest age of life,

and $V^*(a) = \frac{1}{e^{-r^*a}P(a)}\int_a^{\beta} e^{-r^*x}p(x)m^*(x)dx$

with $m^*(x) = m(x)\frac{R_0^*}{R_0}$ is the reproductive value of the female at age a.

Under certain assumptions, expression (7.1) was simplified by Singh *et al.* (1981) as:

$$I' = \frac{B_0 e^{r^* t}}{K B_0^* (r - r^*)} \left[1 - \frac{R_0^*}{R_0} \right] \qquad \text{.........(7.2)}$$

The above expressions (7.1) and (7.2) comes out under the assumption that the age specific fertility rate m(x) decline uniformly. However, in such a process an assumption for uniform reduction at all ages during reproductive period is, in fact, unrealistic (Mitra, 1976).

A more feasible reduction in fertility may be age dependent, and comparatively a higher rate of reduction during later period of reproduction than early stages. Taking this into account Keyfitz's expression (7.1) is simplified in this chapter when reduction in fertility is gradual but more rapid at higher ages *i.e.* when

$$m^*(x) = m(x) \frac{e^{-rx}}{e^{-r^* x}} \qquad \text{..........(7.3)}$$

Such a pattern of reduction in m(x) depends on *x* (age) and increases with the increased value of x. It should be noted that throughout this chapter p(x) and m(x) have the same meanings as p(a) and m(a) respectively.

7.2 Formulation of the Model

Since for stable population, we have

$$1(a) = B_0\, e^{-ra} p(a) \qquad \text{.........(7.4)}$$

Putting the values of 1(a) and v*(a) with $m^*(x) = m(x)\frac{e^{-rx}}{e^{-r^*x}}$ into Keyfitz's expression (7.1), we have

$$I^* = \frac{B_0\, e^{r^* t}}{k B_0^*} \int_0^\beta e^{-(r - r^*) a} \int_a^\beta e^{-rx} p(x) m(x) dx da \qquad \text{.........(7.5)}$$

putting $\int_a^\beta e^{-rx} p(x)m(x)dx = \gamma(a)$

and evaluating the double integral by parts, we get

$$I^{*} = \frac{B_0 e^{r^{*}t}}{KB_0^{*}} \left[-\frac{e^{-(r-r^{*})a}}{(r-r^{*})} \gamma(a) \Big|_0^{\beta} - \int_0^{\beta} \gamma'(a) \frac{e^{-(r-r^{*})a}}{-(r-r^{*})} da \right]$$

$$= \frac{B_0 e^{r^{*}t}}{KB_0^{*}(r-r^{*})} \left[1 + \int_0^{\beta} \gamma'(a) e^{-(r-r^{*})a} da \right] \qquad \ldots\ldots\ldots(7.6)$$

where $\gamma(\beta)=0$

and

$$\gamma(0) = \int_a^{\beta} e^{-rx} p(x) m(x) dx = 1$$

$$I^{*} = \frac{B_0 e^{r*t}}{KB_0^{*}(r-r*)} \left[1 - \int_0^{\beta} e^{-ra} p(a) m(a) da e^{-(r-r^{*})a} da \right]$$

$$= \frac{B_0 e^{r^{*}t}}{KB_0^{*}(r-r*)} \left[1 - \int_0^{\beta} e^{-2r'a} p(a) m(a) da \right], \text{ where } r' = (r - \frac{r^{*}}{2})$$

$$= \frac{B_0 e^{r^{*}t}}{KB_0^{*}(r-r*)} \left[1 - \int_{\alpha}^{\beta} e^{-2r'a} p(a) m(a) da \right], \text{ since m(a)=0 for a} <\alpha \qquad \ldots..(7.7)$$

Thus, when age-specific fertility rate m(x) is replaced by $m(x)\frac{e^{-rx}}{e^{-r^{*}x}}$ the population size at any time t is given by expression (7.7) times the initial population. However, it is difficult to work out the population size at any time t from expression (7.7) due to the integral part of the expression, which cannot be evaluated easily. Mitra (1976) has simplified this type of integral by taking varying assumptions about the distribution of net maternity function p(a)m(a). For example, considering the normality assumption of Lotka (1939), he has shown that

$$\int_{\alpha}^{\beta} e^{-2r'a}\, p(a)\, m(a)\, da \;=\; \frac{e^{r'^2\sigma^2}}{R_0} \qquad \text{.........(7.8a)}$$

where R_0 is the net reproduction rate and $\sigma 2$ is the variance of the distribution of the net maternity function. Again, if it is assumed that net maternity function follows the Wicksell's (1931) modified incomplete Gamma Function, then the integral is simplified as

$$\int_{0}^{\infty} e^{-2r'a}\, p(a)\, m(a)\, da \;=\; e^{r'^2\alpha}\left[\frac{r'+c}{2r'+c}\right]^{K} \qquad \text{.........(7.8b)}$$

where $K = \frac{\mu_1'^2}{\sigma^2}, c = \frac{\mu_1'}{\sigma^2}$ and μ_1' is obtained by using α as the arbitrary origin so that the average age of child bearing μ is equal to $\mu_1' + \alpha$.

Thus, taking the simplified form from (7.8a) and (7.8b) of the integral part of (7.7), the models for population size at any time t are given as :

$$I_a = \frac{B_0\, e^{r^* t}}{KB_0^*(r-r^*)}\left[1 - \frac{e^{r'^2\sigma^2}}{R_0}\right] \qquad \text{....... (7.9a)}$$

$$I_b = \frac{B_0\, e^{r^* t}}{KB_0^*(r-r^*)}\left[1 - e^{-r'\alpha}\left(\frac{r'+c}{2r'+c}\right)^{K}\right] \qquad \text{....... (7.9b)}$$

In the context of developing countries, a very negligible proportion of births occurs outside the range of marriage (Khan and Raeside, 1998). In this connection the mean age at marriage plays an important role in reducing fertility (Yadava and Hossain, 2000). Thus, if age at marriage is raised to α' ($\alpha' > \alpha$) years, then equation (7.7) reduces as

$$I^* = \frac{B_0\, e^{r^* t}}{KB_0^*(r-r^*)}\left[1 - \int_{\alpha'}^{\beta} e^{-2r'a}\, p(a) m(a) da\right] \qquad \text{.........(7.10)}$$

assuming m(a)=0 if $a<\alpha'$ as marriage is requisite condition for childbearing. Again, it is difficult to evaluate (7.10). Singh (1992) has worked out some crude approximations of such type of integrals. If we use the Singh's

approximation then we get (7.11a) and (7.11b) under assumption that maternity function follows Normal and Wicksell's incomplete gamma function respectively.

$$\int_{\alpha'}^{\beta} e^{-2r'a}\ \mathrm{p(a)\ m(a)\ da} \cong \frac{e^{r'^2\sigma^2}}{R_0}\left(\frac{\beta-\alpha'}{\beta-\alpha}\right) \qquad \text{.........(7.11a)}$$

$$\int_{0}^{\infty} e^{-2r'a}\ \mathrm{p(a)\ m(a)\ da} = e^{-r'\alpha'}\left[\frac{r'+c}{2r'+c}\right]^{K}\left(\frac{\beta-\alpha'}{\beta-\alpha}\right) \qquad \text{.........(7.11b)}$$

Thus, taking an increased age at marriage to α' ($\alpha' > \alpha$) years, the models for population size at any time t become

$$I_a = \frac{B_0\, e^{r^*t}}{KB_0^*(r-r^*)}\left[1-\frac{e^{r'^2\sigma^2}}{R_0}\right]\left(\frac{\beta-\alpha'}{\beta-\alpha}\right) \qquad \text{.........(7.12a)}$$

$$I_b = \frac{B_0\, e^{r^*t}}{KB_0^*(r-r^*)}\left[1-e^{-r'\alpha'}\left(\frac{r'+c}{2r'+c}\right)^{K}\right]\left(\frac{\beta-\alpha'}{\beta-\alpha}\right) \qquad \text{.........(7.12b)}$$

Further, let us consider the family planning methods which would accelerate the process of fertility decline. It respect of South Asian countries, it is evident that 65% females are more likely to limit their family size within two children and couples try to complete their family size beginning of their married life. After completing family size females/males used any of the family planning methods to limit their births. Moreover, popularity of female sterilization increases among older women although a negligible per cent (1%) reported to use female sterilization within the age group (15-19) years. So, considering the use of contraception after a certain older age as well as the increased mean age at marriage, reproductive span of life is expected to be shortening by

(α',β') instead of (α,β) where $\alpha' > \alpha$ and $\beta' < \beta$

Now the expression (7.12a) and (7.12b) can be modified as

$$I_a = \frac{B_0\, e^{r^*t}}{KB_0^*(r-r^*)}\left[1-\frac{e^{r'^2\sigma^2}}{R_0}\right]\left(\frac{\beta'-\alpha'}{\beta-\alpha}\right) \qquad \text{.........(7.13a)}$$

$$I_b = \frac{B_0 e^{r^*t}}{KB_0^*(r-r^*)}\left[1-e^{-r'\alpha'}\left(\frac{r'+c}{2r'+c}\right)^K\right]\left(\frac{\beta'-\alpha'}{\beta-\alpha}\right) \qquad \text{.........(7.13b)}$$

Expression (7.13a) and (7.13b) may be treated as a contraceptive type model.

However, proportion of reduction in fertility would not be same as that of the proportion of reduction in the reproductive span. Numerically, if we take α' =20 instead of 15 (α) and β' =35 instead of 45 (β) then the reproductive span of life will be reduced by 15 years and values of the integrand will be

$\int_{20}^{35} p(a)m(a)da = 0.5,$ since $\int_{15}^{45} p(a)m(a)da = 1$ which is practically incorrect as maternity function is not uniformly distributed. In this case, it is assumed that reduction in m(a) depends on age as said earlier and if it is $m^{**}(x) = m^*(x)e^{-\rho x}$, then the population projection model shown by (7.9a) and (7.9b) may be modified as

$$I_a = \frac{B_0 e^{r^*t}}{KB_0^*(r-r^*)}\left[1-\frac{e^{\delta^2\sigma^2}}{R_0}\right] \text{ where } \delta = r' - \frac{\rho}{2} \qquad \text{........(7.14a)}$$

$$I_b = \frac{B_0 e^{r^*t}}{KB_0^*(r-r^*)}\left[1-e^{-\delta\alpha}\left(\frac{\delta+c}{2\delta+c}\right)^K\right] \qquad \text{........(7.14b)}$$

Similarly the other models represented by (7.12a), (7.12b), (7.13a) and (7.13b) could be modified.

Some special cases:

1. If α' =α, then the expression (7.12a) reduces to (7.9a) and (7.12b) reduces to (7.9b).

2. If $R_0^* = \int_\alpha^\beta p(x)m^*(x) = 1$, *i.e.*, when net reproduction rate in the new regime of fertility schedule reduces to the replacement level then $r^* \to 0$, mean age of child bearing in stable population (K) tends to the mean age of child bearing in stationary population (μ) *i.e.*,

$$K = \frac{\int_\alpha^\beta a e^{-r^* a} p(a)m(a)da}{\int_\alpha^\beta e^{-r^* a} p(a)m(a)da}$$

$$= \frac{\int_\alpha^\beta a p(a)m(a)da}{\int_\alpha^\beta p(a)m(a)da} = \mu$$

Also,

$$B_0^* = \frac{1}{\int_0^w e^{-r^* a} p(a)m(a)da} = \frac{1}{\int_0^w p(a)da} = \frac{1}{e_0}$$

Putting these values in expression (7.9a), it reduces to Yadava *et al.*, (1996) as

$$I_a^* = \frac{B_0 e_0}{\mu r}\left(1 - \frac{e^{r^2\sigma^2}}{R_0}\right) \qquad \text{......... (7.15)}$$

Further, for a small value of r it is found that $r^2\sigma^2 \cong 1$, then (7.9a) reduces to Keyfitz (1971) as

$$I_a^* = \frac{B_0 e_0}{\mu r}\left(1 - \frac{1}{R_0}\right) \qquad \text{......... (7.16)}$$

7.3 Numerical Illustrations

The population growth models derived under various assumptions in the previous section are illustrated numerically. To estimate the size of population at any future date, we require to know the values of the demographic parameters $K, B_0, B_0^*, R_0, R_0^*, \sigma^2, r$ and r^*. There is no any official source of population in India which could provide information about all the above mentioned demographic parameters in one set of data and at one point of time. The values of the parameters B_0 (birth rate), r (growth rate) and e^0 (expectation of life at birth) are taken from the Sample Registration Survey (SRS) 1997 data and these are 27.4, .0185 and 63.9 years respectively. The other values of the parameters can be obtained from the maternity function (p(a)m(a)). For this, it is needed to know the values of age specific fertility rate (ASFR) for the current stable population which has been taken from National Family and Health Survey (NFHS) 1995 data because SRS didn't provide the information required for the computation of ASFR. The data has been presented in Appendix Table 7.1, where the computational procedure of m(a) is also given. The values of p(a) are taken from the Regional Model Life Table of Coale and Demeny, 1966 (South, mortality level 13). This level has been chosen due to the similarity in mortality experience of the country under study. The calculated values of the various parameters based on Appendix Table 7.1 are as:

R_0= 1.546, R_1= 39.406, R_2= 1071.667, μ= 28.00, σ^2= 50.06, K= 28.50, k= 2.533, c= 0.242.

Further, in accordance with Government of India's policies about population, let us assume the values of B_0^* (birth rate), R_0^*(net reproduction rate)and r^*(growth rate) as 0.020, 1.150 and 0.010 respectively when population restablise in the new regime of fertility schedule.

The population sizes for different values of t are computed using expressions (7.9a), (7.9b), (7.12a), (7.12b), (7.13a), (7.13b) and these values are compared with that of Singh *et al.* (1981) expression represented by (7.2) (Table 7.1). These values of population size have also been compared with that of Keyfitz (1971) model represented by (7.16) which is obtained when growth rate r^* become zero. That is when population reaches to the state of replacement level with net reproductive rate R_0^* equal to unity. Fortunately, the values of the various demographic parameters for Bangladesh are also available. The proposed models are also illustrated with Bangladesh data. Numerical values of the size of populations projected at different times for Bangladesh are shown in Table 7.2.

Considering the effect of increasing age at marriage, a reduction of about 17% was found in the population size by applying to model 7.12a, in comparison to model 7.9a if age at marriage is taken to be 20 years, whereas combined effect of both adoption of family planning method at an age of about 35 years and an increased age at marriage at 20 years was about 50% of initial population size. However, it is evident that reduction in projected population size is uniformly proportionate with the reduction of the reproductive span (α to β) which is not admissible due to nature of maternity function as mentioned in the previous section. Keeping this in mind some population growth models were proposed as given by expressions (7.14a) and (7.14b). These models provide some more reasonable values of the future population size (Table 7.1). A similar interpretation for each projected values of population size under various models may be have in the case of Bangladesh data. A higher value of population size under the proposed models (7.9a) and (7.9b) in comparison to model (7.2) provides an obvious interpretations. Later models are obtained under the gradual change in fertility schedule whereas the model (7.2) has been obtained under the drastic change in fertility schedule (see figure 7.1(a) and 7.1(b)) which is not realistic due to the population momentum. However, as per rule of the doubling time of a population about 30 years (Yadava *et al.*, 1996), the

population growth models derived under the assumption that the maternity function follows incomplete gamma function seems to be a reasonable approximation. An ultimate population of India and Bangladesh would be about 1.31 and 1.51 times the initial population when net reproduction rate becomes unity (see model 7.16).

7.4 Conclusions

A number of population projection models have been derived under the stability conditions. The models derived under the gradual change in fertility schedule have been compared with the models proposed under drastic change in fertility schedule. Impact of an increase in age at marriage has also been studied as it was found that if age at marriage is increased to 20 years the population size would reduce by 17 percent. The size of population would be about 1.3 times the initial population if net reproduction rate reduced to unity.

Table 7.1: Population size of India for different values of t using different models

Time	Population Size** in India based on SRS data (1997)									
t yr.	7.2	7.9a	7.9b	7.12a	7.12b	7.13a	7.13b	7.14a	7.14b	7.16
20	1.123	2.674	2.177	2.228	2.114	1.337	1.268	2.689	1.765	
30	1.241	2.955	2.406	2.463	2.336	1.478	1.402	2.972	1.950	
50	1.516	3.609	2.939	3.008	2.854	1.805	1.712	3.630	2.382	1.311
75	1.946	4.634	3.774	3.862	3.664	2.317	2.199	4.661	3.059	
100	2.499	5.951	4.846	4.959	4.705	2.975	2.823	5.985	3.927	

** times higher than the initial population. Assuming initial population = 1.

Table 7.2: Population sizes of Bangladesh for different values of t using different models

Time	Population Size** in Bangladesh based on BDHS data (1996/97)									
t yr.	7.2	7.9a	7.9b	7.12a	7.12b	7.13a	7.13b	7.14a	7.14b	7.16
20	2.947	3.595	2.472	2.674	2.401	1.798	1.503	3.613	1.960	
30	3.257	3.973	2.732	2.956	2.653	1.987	1.661	3.993	2.166	
50	3.978	4.853	3.337	3.610	3.240	2.427	2.029	4.878	2.646	1.507
75	5.108	6.231	4.285	4.635	4.161	3.116	2.605	6.263	3.398	
100	6.559	8.001	5.502	5.952	5.343	4.001	3.345	8.042	4.363	

** times higher than initial population. Assuming initial population = 1

Appendix table 7.1: Age Specific fertility Rate (ASFR) and p(a) function

	For India			For Bangladesh		
Age	ASFR	S(x)	P(x)	ASFR	S(x)	p(x)
15	0.116	0.723	0.856	0.089	0.477	0.835
20	0.231	0.959	0.846	0.184	0.757	0.827
25	0.170	0.944	0.834	0.161	0.908	0.815
30	0.097	0.984	0.822	0.105	0.890	0.802
35	0.044	0.866	0.809	0.059	0.881	0.788
40	0.015	0.849	0.796	0.025	0.828	0.773
45	0.005	0.823	0.779	0.004	0.761	0.756

The Computation of m(a)

Since the computation of ASFR includes all the females, this does not take into account whether the female is eligible or not. Thus, dividing these ASFR by the proportion of eligible couples of the particular age group, we can find ASFR for the eligible couples. Further, multiplying by sex-ratio and 5 (due to 5 yearly age-group), we can get the values of m(a), *i.e.*,

$$m(a) = ASFR \times Q \times 5 \times \frac{1}{S(a)}$$

where Q is the sex ratio at birth and S(a) is the proportion of eligibility couples at age a. The value of Q from the survey 1995, is 0.489 female birth per birth and the values of S(a) are presented in the above Table .

Figure 7.1(a): Time History of Net Reproduction Rate under an Abrupt change in Fertility Schedule

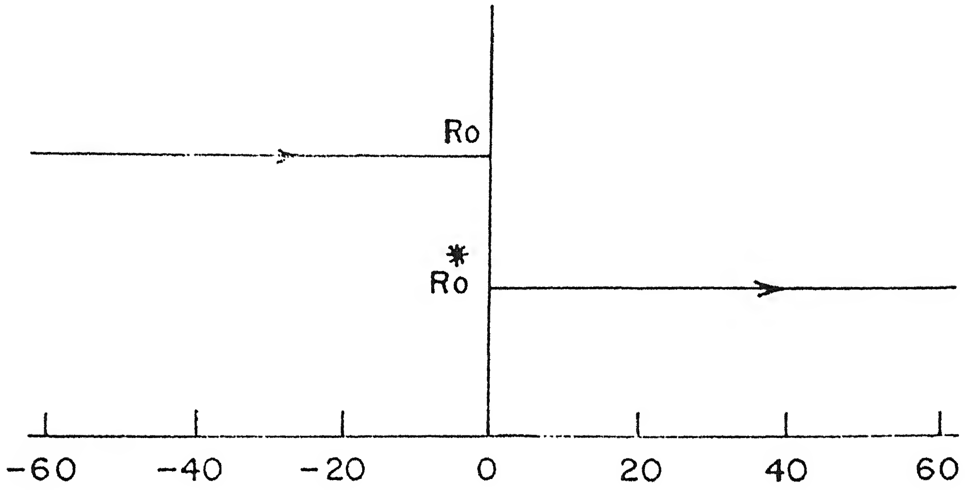
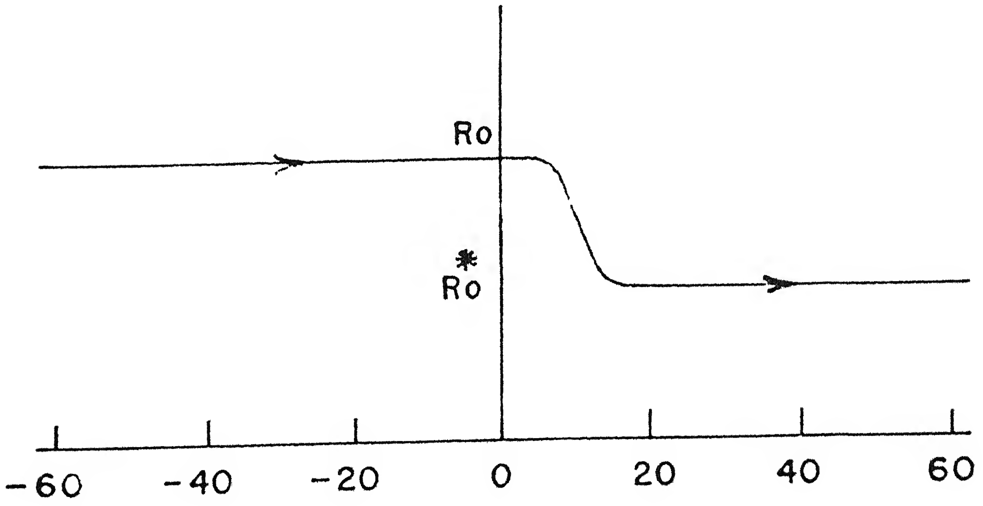


Figure 7.1(b): Time History of Net Reproduction Rate under a Gradual change in Fertility Schedule



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APPENDIX

APPENDIX-A

A SAMPLE SURVEY ENTITLED "EFFECT OF BREASTFEEDING ON FERTILITY IN RURAL NORTHERN INDIA"-1995

The data under this survey was collected in 1995 in five villages around Varanasi, a district in the state of Uttar Pradesh, India. Uttar Pradesh is the most populous state in India and constitutes 16.4% of the total population of the country. Varanasi lies in Eastern Uttar Pradesh, which is a well-defined region in the middle Gangetic plain. This region shares 29.2%of the state's total land area, and about 38% of its population (Census of India, 1991). The population growth rate as well as the fertility and mortality rates for the region during 1981-1991were above the state's average. The density of population for the region in 1991 was 614 persons per square kilometer as against 473 persons for Uttar Pradesh. According to 2001 Census of India, the district Varanasi has become the most populous district of the state.

The culture of Eastern Uttar Pradesh is a product of a mixed heritage of Hindu and Muslim influences. Most of the people in the area have deep-rooted traditional values and their way of thinking and living are governed by the religious and cultural norms. The language of the people is Hindi, although a large percentage of the Muslim population speaks Urdu. About 88% of the population of Eastern Uttar Pradesh live in rural areas compared to 80% of Uttar Pradesh and 74% of India. The occupatioal structure of the workforce in Eastern Uttar Pradesh is heavily skewed in favour of agriculture.

A.1 Choice of listing unit

The choice of listing unit in any sample survey is mainly governed by its objective. Since the main objective of the survey was to examine the effect of breastfeeding on fertility prevailing in different groups of the society, the

data on demographic, economic and social characteristics of the persons as well as of the households to which they belong were needed along with the study variables. For the study of such characteristics a household is generally recognized as the most appropriate unit. So a household is adopted as the listing unit for this inquiry.

A household was defined as a group of persons who resided together and took food from a common kitchen, inclusive of persons who lived outside the village but claimed the household to be of their own. The inclusion of the household level variables in the rural context of the study area is considered appropriate as the behaviour of an individual is influenced by not only her/his characteristics alone, but also by the characteristics of the household to which she/he belongs. People in the household take part in the economic and social activities together, share joys of social living, have strong feelings of mutual obligation during crisis and identify their interest with the household welfare. Normally, resident members exclude guests but include temporary absentees. The migrated persons have also been included in the household because they cooperate in its economic and social activities.

A.2 Data collection

The questionnaire was prepared to obtain information on both households as well as on the individuals levels. The questions included in the schedule were the same as generally adopted in any standard socio-economic and demographic survey. The household schedule contained questions regarding General Identification, Household Composition Record, Household Facilities etc. Further, the Marriage Records in last two years, Birth and Death Records in last one year and description of migration in the household were also put one after another. A separate section of the questionnaire schedule was framed to obtain detailed information about birth records of each individual couple in the household with particular emphasis to last two pregnancies. The questions related to fertility, breastfeeding, PPA, family

planning, precaution during pregnancy, opinion of females about breastfeeding, family planning, family size, dieting habit of the females in daily routine as well as during and after pregnancy, etc., have been considered. The questions related to morbidity behaviour among infant children aged less than use among females have also been asked.

A.3 The basic variables and their measurements

A.3.1 Demographic variables

The variables included were: age of mother (AGEMOTH), age of mother at the birth of the child (AGEMOTC), age at return marriage (AGERM), parity of mother (PARITY), age of child (AGECH), survival status of child (CHALIVE), and sex of child (SEX).

AGEMOTH, AGEMOTC and AGERM were all measured in completed years. The AGERM is the age, at which a couple starts living together for consummation after a ceremony known as Gauna, which may be performed after several years of marriage. The AGECH is measured in completed months. CHALIVE is classified as alive if the last but one child or the last child was alive at the time of occurrence of the next event (*i.e.* at birth of the next child or at the survey date respectively), and dead if the child was dead before the occurrence of the next event.

A.3.2 Socio-economic Variables

The variables included in this category were the type of household (HHTYPE), status of house (HOUSE), main occupation of the household (OCCHH), economic status of the household (ECONHH), social status of the household (SOCIALHH), education of wife/mother (EDUW), and education of husband/father (EDUH).

Type of Household (HHTYPE): The most important human grouping may be of concern for a population study is a household, which is a group of persons who in brief are closely knit together co-operating in economic and social activities. They share the joys of social living, have strong feelings of mutual obligation during crisis and identify their interest with household welfare. Though the study of household is important in itself, its analysis becomes more desirable because the behaviour of an individual is influenced not by his characteristics alone but also among others by the characteristics of the household to which he belongs.

The type of household refers to the kind of relations among its family members. The family is and has always been the most intimate and one of the most important groups. It can be said to be universal; existing in all human societies. It plays an important role in demographic analysis. Consequently, the demographic factors also are critical variables with regard to family formation, composition, change and dissolution. Although, the study of family formation and its impact on various social, psychological and other factors have long been a focus of study by sociologists and anthropologists, very little is known about the Indian system.

It is notable that in Indian context, much confusion prevails about the concept of family and household because of their close relationship to each other and also due to lack of unambiguous definitions for either of them. Usually everywhere, the joint family system exists and its clear definition is complex because of its legal as well as sociological base. The classical definition of joint family was largely given on the basis of property rights and on the basis of 'shradha' or ritual of propitiation of dead ancestors and other scriptural rights. Further, in a number of empirical studies 'Joint family ' is defined as a family composed of two or more nuclear families consisting of male copartner, their offspring and their wives.

In the present analysis **HHTYPE** is defined as:

1. **Nuclear**: comprising of one couple and their children.
2. **Joint:** comprising more than one couple and their children.

HOUSE is classified as kaccha (made of mud), pucca (made with bricks), or mixed. **OCCHH** refers to occupation that mostly contributed to the income of the household.

ECONOMIC STATUS OF A HOUSEHOLD (ECONHH): The economic status of a household should be measured with the help of per capital income. However, it is a well-known fact that income data especially from rural area is not so reliable. Keeping in view this fact, it was decided to define the economic status of a household taking into consideration a number of other factors also, which may be highly correlated with the economic condition of the rural household, apart from per capita income. Economic status of a rural household is a function of a number of interrelated variables like landholding, income sources, occupation characteristics etc.

The total earnings of a rural household has been computed by adding total income in Rupees (Indian Currency) from all possible sources in a household, which is explained in brief as follows:

A. <u>From Agriculture:</u>

i. Assumed income of Rs. 2880/= per acre per annum, if a household has ownership of land at most 0.625 acre, according to average price of agricultural product on the basis of 1991 price.

ii. Assumed income of Rs. 2400/= per acre per annum, if a household has ownership of land greater than 0.625 acre and less or equal to 3.125 acre.

iii. Assumed income of Rs. 1929/= per acre per annum, if a household has ownership of land greater than 3.125 acre and less or equal to 5 acre.

iv. Assumed income of Rs. 1600/=per acre per annum, if a household has ownership of land more than 5 acre.

Further, if a person working himself in his own field, the labour charge was be Rs. 300/== per month in case of male worker and Rs. 150/= per month in case of female worker.

However, in case of cash crop (Adhiya) half of the above income was accounted for.

B. Income from service:

i. In case of commuters 100% of their earnings is considered a household income.
ii. If a person is migrated singly by living his wife, children and others in rural areas, his 50% earnings is accounted for household income.
iii. If a person is migrated with his wife, children and relatives to urban areas only 10% of his total earning is accounted for the household income.

Thus, encircling the above three one may easily get the total income of a household from service.

C. Income from household industry:

Since, there is a vast network of household industry such as carpet as well as Sari weaving in the study region, many of the surveyed households have totally been dependent on these occupations. Therefore, it has been fixed:

i. Rs.1000/= per month per loom, if own loom and one person of the household is himself engaged in that work.
ii. Rs. 500/= per month per loom, if no member of the household is working in that work.

(iii) Rs. 700/= per month per person, if working regularly on the other's loom throughout the month.

D. Income from business:

Income from business has been considered by taking into account the details and almost been dependent on investigator as well as the respondents according to nature of work. But to measure household income from business the same migratory status technique has been adopted as in case of household income from occupations of service.

Thus the total monthly income of a household has been calculated by compiling the monthly income from these aforesaid sources of income and utilized in computation of income index of a household. The income index of a household is defined as the ratio of total earning from all sources of a household to effective size of the household. The effective size of the household is defined considering each person aged 15 years and above as one unit and less than that years as half unit.

Therefore, after calculating the total earnings from all-different sources and effective size of the household, the income index (I.I.) is calculated as:

$$\text{I.I.} = \frac{\text{Total earning of a household}}{\text{Effective size of the household}}$$

Then, the economic status of a household based on (I.I.) is classified in to three groups as:

Economic status	**Income Index (I.I.)**
1. LOW	< Rs.301/= p.m.
2. MIDDLE	Rs. 301/= p.m. to 500/=p.m
3. HIGH	> Rs. 500/= p.m.

SOCIAL STATUS OF THE HOUSEHOLD (SOCIALHH): Social status in India, particularly in rural areas is not only a function of caste and landholdings but also of life style. Distinctive styles of life are determined through differences in education, housing etc. The expenditure on rural households on these items is not only determined by their income but also Is closely related to their aspiration of either maintaining their status or achieving upward social mobility.

The term social status, not used here in the general sense, is associated with many factors. In fact, it is not easy to define and quantify social status of a household. Since it depends upon several interrelated factors. The social status of a household can be obtained in several ways, but it has been defined on the basis of different kind of facilities available in a household. For completeness those are as follows:

1. Total income in excess of Rs. 3000 per month,
2. Land possession in excess of 3.125 acre,
3. Residential accommodation more than one ' PUKKA ROOM' per eligible couple,
4. Regular use of milk and vegetables,
5. Education at graduate level of at least one member of the household,
6. Possession of at least two of the following facilities:
    i) Drinking water facilities
    Well/ Hand Pump/ Pumping Set
    ii) Entertainment facilities
    Radio/ Tepricorder/ T.V./ V.C.R.
    III) Travelling or transportation facilities
    Bicycle/ Scooter/ Motorcycle/ Car/ Jeep
    iv) Luxurious items
    Fan/ Cooler/ Freeze/ Heater
    v) Agricultural equipment
    Ox/ Plough/ Tractor

v) <u>Kitchen facilities</u>

Gas Chulaha (Stove)/ Bio- gas Chulaha

vii) <u>Other facilities</u>

Electricity/ toilet

Having examined the surveyed household in light of presence of above facilities their social status has been classified into three different groups as follows:

1. LOW: If at most one facility is available in the household.
2. MIDDLE: If two or three facilities are available in the household.
3. HIGH: If four or more facilities are available in the household.

It is important to mention that similar indices may be prepared in other studies taking account of the existing conditions in the locality and community.

Both education variables **EDUW** and **EDUH** are categorized according to the years of schooling as follows: (I) illiterate (no schooling) (ii) primary (1 to 5 years) (iii) middle (6 to 8 years) (iv) high(9 to 10 years) (v) inter+(class 11 years and over).

A.3.3 Cultural variables

Two variables included are religion **(RELIGION)** and caste **(CASTE)**. **RELIGION** is split into two categories as Hindus and Muslims.

CASTE GROUP (CASTE): In rural areas caste forms a nice cultural stratification and plays an important role in determining the distribution of various population characteristics. Consequently, the differentials in population characteristics have been analyzed taking caste as an explanatory variable.

In the present survey, most of the households (about 87%) were of Hindu and the rest Muslims. The Hindu households consisted of about 35 castes. These castes were stratified into four categories on the basis of their homogeneity as per the pattern of living, performing social activities, and their relative position in rural society. Because the number of caste were too large for statistical comparisons and many of them were just nominal in sampled units. Muslim households were also found to belong into various sub-castes. However, being small in number (13%) were not divided into categories. The caste groups, therefore, are:

1. HIGH CASTE: Brahmin, Kshtriya, Bhumihar, Kayastha, Brahmabhatta, Gosain and Mahabrahmin - Landlords, relatively well educated, living in joint family system, economically well off.
2. MIDDLE CASTE : Kurmi, Koiri, Ahir, Gareria.- Mostly agriculturists
3. BUSINESS CASTE: Bania,Teli, Thatera, Sonar, Kalwar, Halwai, Barai, Kahar, Kohar, Lohar, Nai, Mali, Mallah, Bind, Nonia, Rajbhar, Nishad.- Mostly landless, involved in business of any kind.
4. SCHEDULED CASTE: Khatik, Dharkar, Dhobi, Nat, Pasi, Bhangi and Musahar-- Relatively less educated, economically poor, labourers
5. MUSLIMS